The potential for reduction of greenhouse gas emissions in the milk production sector

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Abstract

The thesis presents results on analyses of the greenhouse gas (GHG) emissions reduction potential in the milk production sector. The growing interest on environmental impact justify a GHG analysis of the milk sector at the European level, distributing the main gases emitted in milk production chain, and the processes where these emissions are produced. This analysis shows that at the European level, 1,62 kg $CO_{2\ eq}$ kg of milk^{-1} are emitted along the milk production chain, with different importance of stages and gases. According to the GHG distribution, there is an analysis of reduction strategies at the industry level. The calculated reduction potential is 16,18% less emissions in milk production, with different potential reduction according to stages of the milk production cycle.

A questionnaire distributed among milk consumers shows that there is receptivity for changing the brand purchased by consumers if the industry shows them the efforts made to reduce environmental impact, with an analysis of the consumers groups more willing to change their decision.

Language: English Key words: Greenhouse gas , Milk, Reduction, Consumers

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1. Introduction

The Present thesis aims to find the best chances for the industry of dairy milk to reduce the environmental impact in form of greenhouse gas (GHG) emissions in milk production life cycle. Moreover, the thesis aims to know how consumers need to receive the information about these considerations for changing its purchasing decisions to more environmental responsible milk.

1.1. Milk Sector

Milk sector has been selected because of its environmental impact, and for its wide distribution, with multiple type of farms and industries. Among human activities, agriculture is estimated to be the fourth contributor of greenhouse gas (GHG) emissions on a global level, after energy supply, industry and forestry (IPCC, 2007, 36). Agriculture includes animal production as agrarian activity and it is perceived to be much more harmful for global warming (that it really is), probably because it has an impact not only on climate change, but also on acidification, eutrophication, ozone depletion, reduced water resources, loss of biodiversity and soil erosion (Pirlo, 2002, 109). This multi-affect is confirmed in diary sector that generates environmental impact in different fields like greenhouse gas emissions, eutrophication and soil degradation (Yan, 2010, 1).

Not only does diary activities affect several environmental spheres, but it is also a sector that consumes many inputs coming from different sectors (e.g., feed, fertilizers, energy), and produces several outputs with diverse affections. In fact, according to Hospido (2003, 784), the dairy industry is one example of a sector characterised by the association of different productions systems: agriculture, livestock, dairy farming, dairy packaging and product distribution.

The environmental impact of the milk sector should not be a reason to cut down milk production, especially because the importance of the dairy sector has an outstanding position as being important staple food (Hospido, 2003, 785). Instead, there is a need to encourage milk sector to reduce GHG, assuring milk supply with the lowest environmental impact.

1.2. Life-cycle assessment

One of the most internationally accepted methods for assessing the global impact associated to activities or products is life-cycle assessment (LCA) (Hospido, 2003, 783; IDF, 2009, 10; Pirlo, 2002, 109; Yan, 2010, 1). LCA addresses the environmental aspects and potential environmental impacts throughout a products life cycle from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal (ISO, 2006a, v). It is, so, an adequate method to obtain information of certain environmental impacts as GHG emissions in a production process.

LCA can assist on: (i) identifying opportunities to improve the environmental performance of products at various points in their life cycle; (ii) informing decision-makers in industry, government or non-government organizations (e.g. for the purpose of strategic planning, priority setting, product or process design or redesign); (iii) the selection of relevant indicators of environmental performance, including measurement techniques, and (iv) marketing (e.g. implementing an ecolabelling scheme, making an environmental claim, or producing an environmental product declaration) (ISO, 2006a, v).

LCA is also the only method that by definition evaluates production in terms of relative impact per unit product (Yan, 2010, 1) and can be used in international benchmarking, economic and social planning, eco-labelling, verification of technical innovation or evaluation of the results of the adoption of mitigation strategies (Pirlo, 2002, 109). LCA can be used to identify environmental improvement opportunities and to optimise product and process optimisation, design and innovation (Hospido, 2003, 783), being the former one of the main aim of the present thesis.

Moreover, LCA can assist in identifying opportunities to improve the environmental performance of products at various points in their life cycle (IDF, 2009, 10), as it offers a comprehensive analysis of environmental impact through the whole product life cycle, including the extraction of raw materials, manufacturing of materials and products, use, reuse and disposal of wastes (Bormann, 2011, i).

Researchers from European countries, where animal husbandry is important, have applied LCA to milk production in response to environmental impact concerns (Yan, 2010, 1), so it is a method already used in the thesis topic. Studies goal usually consists of two parts: (i) to find “environmental hotspots” within one or more production modes, or to identify the role of tactical decisions within one system, and (ii) to suggest possible improvements or the consequences of implementing changes (Yan, 2010, 2).

LCA is an adequate method to identify where milk production has environmental impact and what the best strategies for cutting down it are, and so it has been used in the present thesis.

1.3. Greenhouse gases and Global Warming

There is a growing interest in society about environmental issues, as a result of the number of researches and studies about how human actions affect environment, and also because there are more and more evidences of the real affection of these actions to human sphere. In this regard, "*there is increasing public concern about the effects of global warming on human health, food-supply, water resources, and other environmental issues, since dramatic events are expected in the future"* (Pirlo, G. 2002, 109), so the effects on global warming by any human action is important by itself and by the effects associated to it. This public concern is making society aware about the impacts on environment of human activities. This fact is increasing the interest on knowing about the affection that people actions have on the environment and how these actions can be modified in order to reduce the negative effects.

Public concern is accompanied by efforts to reduce GHG at different levels. Europe leads the actions for this purpose at global level, with different programmes and a framework to achieve ambitious targets in 2020 and 2030. Some of these actions are Emissions Trading Systems (ETS), National emission reduction targets, Renewable energy-national targets and Innovation and financing, with the general goal of cutting down 20% of GHG (from 1990 levels) in 2020 (European Commission).

Public concern about environmental impacts associated to human activities is related, so, with the efforts of public institutions in the reduction and mitigation of those affections. In case of Europe, the policy of GHG emissions reduction is a crosscutting action affecting several sectors and decisions, so the general goal of cutting down 20% of GHG by 2020 is a target to be considered in any human activity.

The importance of dairy sector in terms of GHG emissions is 3% - 4% of total anthropogenic greenhouse gas (Henriksoon, 2011, 1474) globally. According to Pirlo (2002, 110), milk sector represents the main source of GHG of all livestock and poultries.

Those data show that milk sector is, within the agrarian sector one of the main contributors to GHG. Most of the analysed initiatives to reduce the environmental impact of dairy industry studied by IDF (2009, 5) consider greenhouse gases (19), with water aspects in second position (9) and energy in third position (8). It means that GHG emissions are considered as the main impact of milk production, so it is important to analyse its reduction potential, with the goal of reduction of 20% by 2020 as main target.

Focussing this analysis to only one gas, ruminant livestock produce about 80 millions tons of methane annually, accounting for about 22% of global methane emissions from human-related activities (Hospido, 2003, 783).

The importance of dairy sector in terms of contribution to GHG, and the efforts to reduce emissions make it necessary to look for and implement measures with the aim of reducing sector contribution to global warming, so in this study, within LCA results, Global Warming Potential (GWP) has been chosen to evaluate the impact of dairy sector in terms of $CO_{2\ eq}$.

In line with the thesis purpose, LCA will be used to allocate current milk sector greenhouse gases (GHG) emissions, and alternatives to lessen the activity impact will be analysed, so as to identify the best chances of dairy sector for cutting down GHG. Options to reduce GWP are focussed on farm management alternatives, changes on outputs management, introduction of renewable energy systems in dairy farms and optimize the equipment energy consumption through energy efficiency devices, which would mean a reduction in terms of energy consumption and as consequence, in terms of GHG emissions.

In the scenario of applying measures to reduce GHG emissions associated to milk production, milk industry will be in line with the general efforts of European Commission to cut down the impact of any activity. If the reduction is in the proximity of 20% by 2020, milk sector will be able to take a stance as a sector worried about its environmental impact, leading a tendency that can make the sector benefit from the growing interest of people in lessen the impact of its action.

In contrast, if the sector of milk production cannot find the way to reduce its impact in line with public concern, it can be adversely affected by consumers' penalty and by direct or indirect punishment of public bodies and institutions for not fulfilling the targets of GHG reduction.

1.4. Information required by consumers

The thesis also aims to identify the information that consumers need to receive in order to make them change their purchasing decisions. The challenge is to identify how dairy sector and milk industries have to show their efforts in cutting down environmental impact for making consumers select brands with low environmental impact.

For the purpose of obtaining this information, it has been sent a survey to ask consumers for their ideas about dairy sector impact, and their willingness to choose certain products if they receive appropriate information about the efforts that producers make in terms of environmental impact.

2. Material and methods

2.1 Life cycle assessment

Life cycle assessment (LCA) procedure requires four steps: (i) goal and scope definition, (ii) life cycle inventory (LCI), (iii) life cycle impact assessment (LCIA) and (iiii) interpretation (ISO 2006a, v).

2.1.1 Goal and scope definition

Goal and scope definition stage defines the system boundary and level of detail. A Functional Unit (FU), system boundary and allocation procedures are defined, depending on the subject and intended use of the study (Yan, 2010, 2). FU is the reference to compare different studies, as the impact is given per unit. In terms of milk, FU is chosen by kg of milk, but there are chances to determine if this milk is Energy Corrected Milk (ECM), Fat and Protein Corrected Milk (FPCM), etc, depending on each research accuracy.

For this thesis, Functional Unit (FU) is kg of packaged milk, because the variability of studies makes it difficult to compare results defining a more detailed FU and according to the study purpose, it is not necessary to narrow the FU definition, so data coming from different FU have been used.

System boundary is the frame where the study is conducted. Milk production has different stages that go from food production to products end-of-life. In terms of milk production, general system boundaries are at the farm gate, covering all the stages before milk is sent out of the farm, and the whole cycle, covering also the stages of milk processing after the farm gate. A normal distribution of the stages of the whole cycle can be seen in Figure 1 (Dairy farm; Dairy; Distribution; Retailer; Consumer; End-of-life).

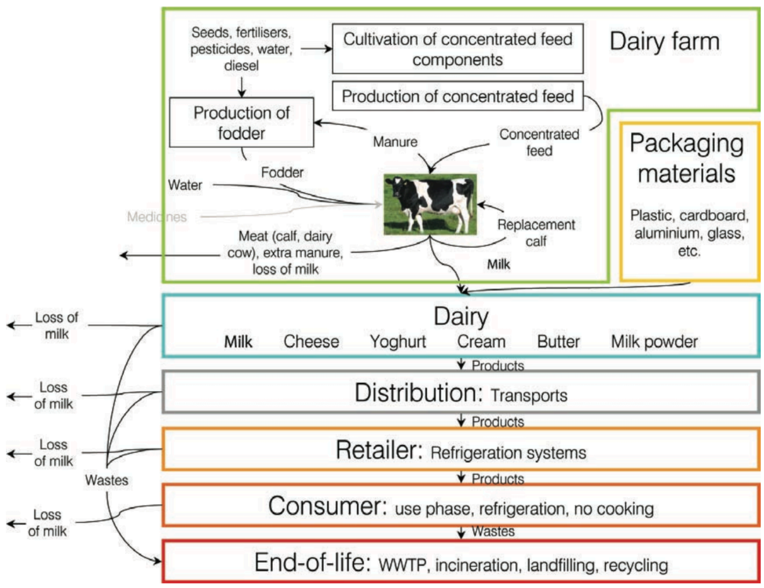

Figure 3.1: boundaries: all phases described are included in the system studied.

Figure 1. Stages in milk production chain. From the top to the bottom, each square represents the stages in milk production. Dairy farm stage contains the impact associated to animal feed production. The rest of stages in which the milk production process is divided in terms of impact analysis are Packaging materials, Dairy, Distribution, Retailer, Consumer and End-of-life. Bornmann (2011)

The system boundary for this thesis covers all the milk production stages, so in proportion to LCA nomenclature, the boundary is “from cradle to grave”. It has been selected the stages suggested by Bornmann (2011, iv) who presents data of LCA from cradle-to-grave and divides contribution to carbon footprint along the whole cycle in seven stages: (i) Farm; (ii) Purchased feed; (iii) Processing; (iv) Packaging; (v) Distribution; (vi) Retail and (vii) Consumer. Despite the thesis goal covers all the stages in milk production, researches with boundary from-cradle-to-farm-gate have been considered, taking into account that these researchers only covered the impact generated in (i) and (ii).

2.1.2 Life cycle inventory

Life cycle inventory (LCI) step consists in an inventory of input/output data of the system boundary defined in the previous stage. This stage is not developed in this thesis for a specific farm, as it has been compiled based on average data for farms.

2.1.3 Life cycle impact assessment

Life cycle impact assessment (LCIA) step aims to provide additional information to help assessing a product system’s LCI results for a better understanding of their environmental significance. LCA studies offer information about abiotic resource depletion, land use, climate change, stratospheric ozone depletion, human/eco-toxicity, photo-oxidant formation, acidification and eutrophication (Guinée, 2002, 63).

Not all the analysed researches contain information about all those outputs, being Climate Change the most common impact studied by LCA studies (Yan, 2010, 5). This thesis has considered climate change as the main impact, measuring it in terms of Greenhouse gases emissions.

2.1.4 Interpretation

Interpretation consists on the explanation of previous LCA stages, in order to explain what results mean. For this thesis, interpretation has been done for average farms in Europe, using data not from specific farms, but from general studies. The reason for doing that is because the study aims to offer alternatives for a sector, not for a specific country or farm.

This means that results have to be interpreted as general recommendations for milk sector. If a country, region or farm need more accurate results for its reality, it will need to analyse it in detail, with these thesis results as a general framework that has to be tailored according to particular situations.

2.2 GHG emissions in milk sector

The purpose is to define a general distribution of Greenhouse gases along the milk production chain, defining what gases are emitted and where. A literature review about GHG in milk sector has been conducted. The selected studies are focussed on developed regions such as South Africa (Bornmann, 2011), USA (Thoma, 2013) or Europe (Henrikson, 2011; Hospido, 2003; Leschen, 2011; Pirlo, 2012; Torquati, 2015; Yan, 2010). Within the existing researches, data have been obtained from studies at European level, or including a representative number of developed countries, as the thesis goal is offering a general framework for European milk sector.

It is not the objective of this thesis to compare studies, but to offer a general framework to allow the identification of main production stages in terms of environmental impact. In this regard, according to Yan (2000, 5), despite of differences among researches, the main impacts of milk production are similar among studies, which is perfectly in line with thesis goal. That is so it will allow to find out the main impacts along the milk production process and to identify where the efforts to reduce GHG emissions can be more profitable.

This general framework has been elaborated from more general to more specific logic. GHG emissions distribution “at-the-farm-gate” and “after-the-farm-gate” has been calculated based on average data from general researches.

The gross amount of GHG along the entire lifecycle has been considered based on a research that offers data of emissions at farm gate coming from 27 European countries. The quantification of the rest of the emissions after the farm gate has been calculated based on the previous distribution.

Once the distribution of emissions at the farm gate and after the farm gate is done in percentage and gross amount for average Europe, the next step is the definition of the gases emitted. This step is based on researches setting gases distribution in percentage at-the-farm-gate, an average calculation and corrections to adapt it to 100%, because the sum of partial average does not sum 100%. Allocation and distribution of gases after the farm gate is based on direct allocation for CO_2, the only gas emitted in those stages.

Last step is the allocation of gases per stage. For this level, it has been analysed stages where different gases are produced along the milk lifecycle. Quantification of each stage contribution has been done using IPCC references when available and bibliography if not. The quantification of GHG emissions for this thesis uses $CO_{2\ eq}$ in 100 years lifetime, as suggested by IPCC (2007, 2.10.2), with 25 Global Warming Potential (GWP) 100-yr for CH_4 and 298 GWP 100-yr for N_2O.

2.3 GHG reduction potential

GHG reduction potential has been analysed based on the origin of gases emissions along the milk production chain, indeed per stage and per gas. Stages have been selected according to from-cradle-to-grave system boundary. Gases analysed are methane, nitrous oxide and carbon dioxide.

For the stages where IPCC Guidelines for National Greenhouse Gas Inventories calculates emissions based on different and clear factors, it has been considered the hypothesis of less harmful factor to analyse potential reduction on average. This chance requires consider TIER 2 methodology in some cases. For the rest of stages, a literature review of chances to cut down emissions has been conducted. In both cases, factors or chances have been selected based on European data, because the thesis goal is offering a general frame of where GHG can be reduced. Selected gases are in line with IPCC (2007) guidelines, with three gases analysed. The impact associated to those gases is allocated to the stages where gases are emitted.

2.4 Consumers preferences

For conducting the study about environmental consumers preferences, an on-line survey in English, Finnish and Spanish, was used. The questionnaire was based on Google forms online tools and circulated by personal email (325 contacts), Novia University email (more than 2.500 contacts) and social networks (Facebook). When questionnaire was sent or posted, it was asked to resend it to other contacts. Questionnaire was shared 20 times in Facebook and there is no way to check how many times it was re-sent by email. Questionnaire was first sent and posted on 07/10/2016, and closed to receive more answers on 19/12/2016.

The questionnaire (Appendix 1) was divided in six sections. Section 1 was a presentation of the survey, the purpose of the questionnaire and two links to the questionnaire in different languages of the selected survey (in English questionnaire, links to Spanish and Finnish, etc). Section 2 contained "Personal Information", where personal data about the studies, job or children were asked. Section 3 contained "Milk Consumption Habits" questions, in order to obtain information about how consumers consume milk and what the most important factors to explain consumption are. Section 4 asked about "Milk Sector Environment Impact", where questions about milk environment impact perception were asked. Section 5 asked about "Factors to Change Purchasing", and there were questions to identify chances to modify milk-purchasing decisions. Last section, number 6, asked for the email of the surveyed in case he/she wanted to receive more information about the study. Questionnaire answers were compiled and analysed with Excel. The analysis has consisted in a general study of all the answers.

3. Results

3.1 GHG emissions in milk sector

Within the stages suggested by Bornmann (2011, i), most of GHG emissions are produced at farm level with different quantities depending on the study: 80,32% (Hospido, 2003, 789); 80% GHG (IDF, 2009, 14); 78%-83% for North America, Western Europe and Oceania (FAO, 2010, 33), so 80,27% is considered as the average of GHG emissions produced at the farm gate in milk sector. Consequently, 19,73% of GHG emissions are produced after the farm gate (Figure 2).

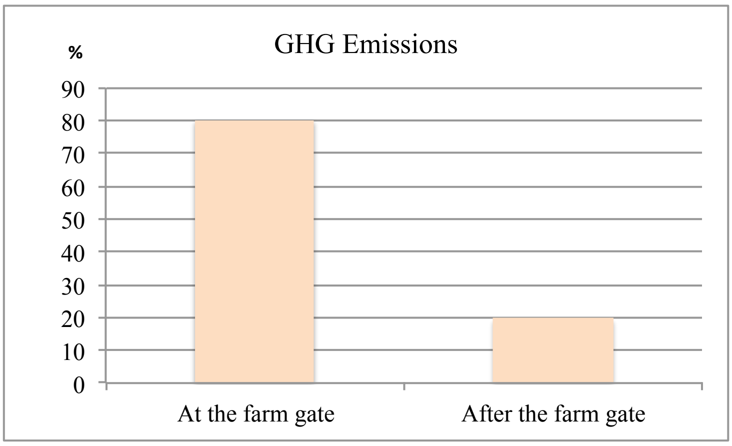

Figure 2. Distribution of GHG emissions (%) at the farm gate and after the farm gate. 80,27% of emissions are produced "at the farm gate", including the inputs related to feed production affection and the emissions produced by cows. The rest of emissions, 19,73% are produced once the milk comes out of the farm.

The average has been calculated based on the results affecting Europe and similar regions in terms of development (North America and Oceania) because there are great differences with non-developed regions in terms of gross GHG and distribution along the lifecycle. This data are in line with IDF 2009, which analyses 60 studies about milk sector impact and the average of global warming potential per stage suggests that there are 20% of emissions before the farm gate, as can be seen in Figure 3.

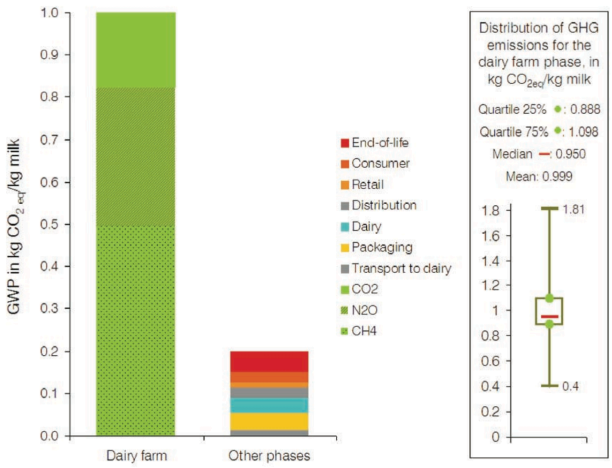

Figure 3. Global Warming Potential of Milk. On the left, Global Warming Potential in kg CO_{2eq}, for 1 kg of milk in different phases of the life cycle (data correspond to means). On the right, the box plot showing the distribution and variation of the collected data in the different studies for the dairy farm phase. The percentile 5% and 95% are respectively 0,61 and 1,61 kg CO_{2eq}/kg milk. (IDF, 2009)

Once an average distribution "at" and "after" farm gate is defined, it is necessary to know a framework of gross amount of emissions. The quantification of global warming potential associated to farm level broadly varies depending on the location and farm type. At global level, greater differences are associated to industrialisation level, with highest values in sub-Sahara Africa (7,5 kgCO_{2eq} per kgFPCM at the farm gate) and the lowest for the industrialized regions of the world (1-2 kgCO_{2eq} per kgFPCM at the farm gate) (FAO, 2010, 33).

Narrowing the region to Europe scale, according to Lesschen et al (2011, 17), 27 countries of the European Union averaged around 1,3 kgCO_{2eq} · kg of milk^{-1} at the farm gate, with great variations depending on the efficiency of the cattle. Henriksoon (2011, 1480) offer similar results analysing Swedish farms, with an average of 1,13 kgCO_{2eq} kg of milk^{-1} at the farm gate, with large variations among farms.

It has been considered Leschen et al (2011, 24) data, 1,30 kgCO_{2eq} · kg of milk^{-1} at the farm fate, for being representative in Europe. According to the previous distribution of emissions at the farm gate (80,27%) and after the farm gate (19,73%), if 1,30 kgCO_{2eq} · kg of milk^{-1} are the emissions at the farm gate, 0,32 kgCO_{2eq} kg of milk $^{-1}$ are the emissions after the farm gate, so 1,62 kgCO_{2eq} · kg of milk^{-1} are the total emissions for milk produced in Europe.

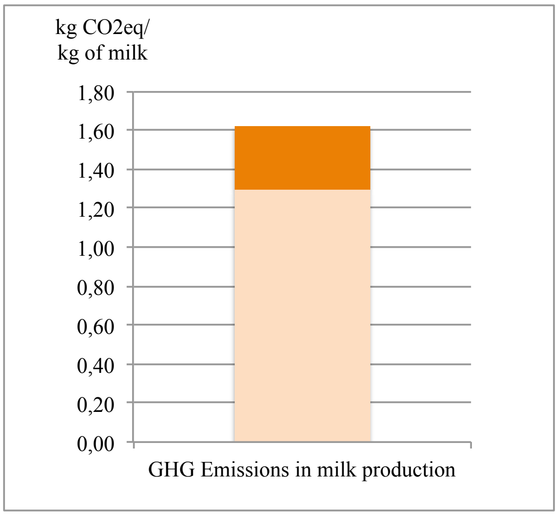

Figure 4. Gross emissions (kg CO_{2eq} · kg of milk^{-1}) in milk production. Pale bar represents emissions at the farm gate (1,30 kgCO_{2eq} · kg of milk^{-1}), and dark bar represents emissions after the farm gate (0,32 kgCO_{2eq} · kg of milk^{-1}).

Global warming potential of milk production is the result of the emissions of three main gases: (i) CH_4 which derives from enteric fermentation and from decomposition of organic matter of manure, (ii) N_2O which is primarily formed at the end of the denitrification and nitrification of organic N of manure and urine and of N of chemical fertilizers and (iii) CO_2 which is emitted on the combustion of fossil fuels used for moving tractors, production electricity and manufacturing chemical fertilizers, seeds, etc (Pirlo, 2002, 109). In proportion to this distribution, CH_4 and N_2O are emitted only in at-the-farm-gate stages and CO_2 is emitted along all the milk production process.

Within those gases, CH_4 is the highest contributor to the farm gate carbon footprint with deviations among studies (50%, IDF, 2009; 26%-40% (Bornmann, 2011); 33% (Hospido, 2003); 46% (Henriksoon, 2011)); N_2O is the next most significant gas (33% (IDF, 2009); 18-32% (Bormann, 2011); 35% (Henriksoon, 2011)) and CO_2 the last one in global warming potential (16% (IDF, 2009); 18% (Henriksoon, 2011)).

Considering these data, it has been calculated the average for these gases, resulting 40,5% of CH_4, 31% of N_2O and 17% of CO_2 at the farm gate. As different gases averages do not sum 100%, as it does each research individually, the obtained average has been multiplied for a factor to complete 100%. The sum of all the percentages is 88,5%, so it should be applied a factor of 1,13 to get 100%. In order to correct it, each percentage has been multiplied for this factor, and then the considered distribution of GHG at farm gate is 45,76% of CH_4, 35,03% of N_2O and 19,21% of CO_2 at the farm gate.

Considering previous data of 1,3 kg $CO_{2\,eq}$ · kg of milk^{-1}, it means that at farm gate, CH_4 represents 0,59 kg CO_{2eq} · kg of milk^{-1}, N_2O 0,46 kg CO_{2eq} · kg of milk^{-1} and CO_2 0,25 kg CO_{2eq} · kg of milk^{-1}. Taking into account that CO_2 is the only gas emitted after the farm gate (0,32 kg CO_{2eq} · kg of milk^{-1}), it means that CO_2 represents 0,57 kg CO_{2eq} · kg of milk^{-1} (Figure 5).

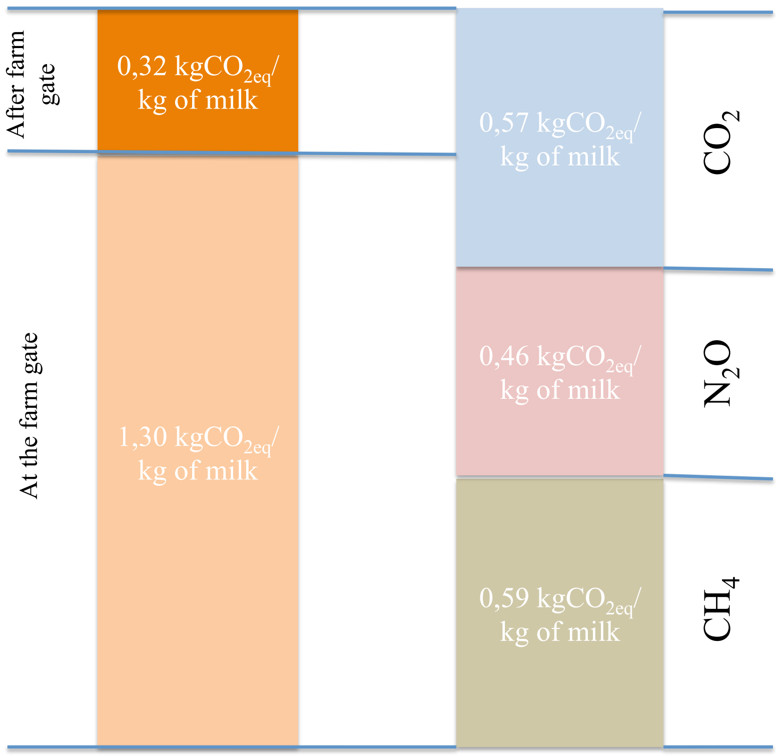

Figure 5. On the left, gross emissions (kg CO_{2eq} · kg of milk^{-1}) per stages (at the farm gate and after the farm gate). On the right, gross emissions (kg CO_{2eq} · kg of milk^{-1}) per gases (CH_4, N_2O and CO_2)

The next step should be having a more detailed allocation of gases according to different stages of the milk production process. It has been analysed gas by gas the actions where emissions are produced.

CH_4 emissions at farm gate are composed by enteric fermentation and manure management methane emission factors. The percentage of each source is obtained from IPCC (2006) data and then applied to the amount of CH_4 agreed for this thesis at European average.

For enteric fermentation, IPCC (2006, 10.29) offers an emission factor of 117 kg CH_4 · head^{-1}·year^{-1} and production yield of 6.000 kg milk· head^{-1} · year^{-1} in Europe (IPCC, 2006, Chapter 10. table 10.11). Considering the Global Warming Potential (GWP) of 25 for methane (IPCC, 2007, 2.10.2), it means that TIER 1 Emission Factor suggests 0,4875 kg CO_{2eq} · kg of milk^{-1} associated to CH_4 for enteric fermentation in Europe.

For manure management, considering the average temperature of 19ºC, CH_4 emission factors are 47 kg CH_4· head^{-1} · year^{-1} in Europe (IPCC, 2006, 10.38). Assuming suggested yield of 6.000 kg milk · head^{-1} · year^{-1}, it means that emissions from enteric fermentation are 0,1958 kg $CO_{2\ eq}$ · kg of milk^{-1} for 19ºC mean temperature in tables.

Both data are used to determine the distribution of CH_4 depending on the origin, as CH_4 is emitted from these processes. Those gross quantities mean that 71,34% of CH_4 emissions at farm gate come from enteric fermentation, while 28,66% has its origin on manure management. Using this percentages in the CH_4 emissions agreed on average, 0,6 kg CO_{2eq} · kg of milk^{-1}, the distribution is 0,43 kg $CO_{2\ eq}$ · kg of milk^{-1} associated to enteric fermentation and 0,17 kg $CO_{2\ eq}$ · kg of milk^{-1} from manure management.

N_2O emissions at farm gate are composed by manure management and decomposition of chemical fertilizers used on crop production to feed cows. Manure management emissions are divided in direct and indirect.

Direct emissions for manure management are calculated according to Equation 1 (IPCC 2006 chapter 10, Equation 10.25), considering one head of livestock ($N_{(T)}$).

$Nex_{(T)}$ result is 105,12 kg N animal^{-1} yr^{-1}, obtained from Equation 2 (IPCC 2006 chapter 10, Equation 10.30) with data of Table 1.

Table 1. Data considered to calculate $Nex_{(T)}$ in Equation 2.

Factor	Value	Unit	Source
$N_{rate(T)}$	0,48	kgN · (1.000kg animall mass)$^{-1}$ · day^{-1}	IPCC 2006 chapter 10, Table 10.19
TAM	600	kg · animal^{-1}	IPCC 2006 chapter 10, Table 10A-4

$MS_{(T,S)}$ and $EF_{3(S)}$ in Equation 1 presents different values according to the type of manure management system. It has been considered the factors of Table 2. Introducing these data in Equation 1, the result is that Direct N_2O emissions are 1,26 kg N_2O animal^{-1} year^{-1}.

Table 2. MS $_{(T,S)}$ and EF $_{3(S)}$ factors for different manure management systems to calculate Equation 1.

Manure mangement system	$MS_{(T,S)}$	EF $_{3(S)}$
Liquid/slurry	35,7%	0,005 kg N_2O-N/kg Nitrogen excreted
Solid storage	36,8%	0,005 kg N_2O-N/kg Nitrogen excreted
Pasture/Range/Paddoc	20,0%	0,02 kg N_2O-N/kg Nitrogen excreted
Daily Spread	7,0%	0 kg N_2O-N/kg Nitrogen excreted
Source:	IPCC, 2006 chapter 10, Table 10A-4	IPCC, 2006 chapter 10, Table 10.21

$$N_2O_{D(mm)} = \left[\sum_S \left[\sum_T \left(N_{(T)} \bullet Nex_{(T)} \bullet MS_{(T,S)}\right)\right] \bullet EF_{3(S)}\right] \bullet \frac{44}{28}$$

Equation 1. Direct N_2O *emissions from Manure Management*

(IPCC 2006 chapter 10, Equation 10.25)

$$Nex_{(T)} = N_{rate(T)} \bullet \frac{TAM}{1000} \bullet 365$$

Equation 2. Annual N Excretion Rates

(IPCC 2006 chapter 10, Equation 10.30)

For calculating N_2O indirect emissions from manure management it has to be obtained before N $_{volatilization\text{-}MMS}$ according to Equation 3 (IPCC 2006 chapter 10, Equation 10.26), considering one head of livestock ($N_{(T)}$). $Nex_{(T)}$ result is 105,12 kg N animal^{-1} yr $^{-1}$, obtained from Equation 2 (IPCC 2006 chapter 10, Equation 10.30) with data of Table 1. MS $_{(T,S)}$ and Frac $_{GasMS}$ in Equation 3 presents different values according to the type of manure management system. It has been considered the factors of Table 3. Introducing these data in Equation 3, the result is that N volatilization is 31,34 kg N · animal^{-1} · year^{-1}.

Table 3. MS (T,S) and Frac $_{GasMS}$ factors for different manure management systems to calculate Equation 1.

Manure mangement system	$MS_{(T,S)}$	Frac $_{GasMS}$
Liquid/slurry	35,7%	40,0%
Solid storage	36,8%	30,0%
Pasture/Range/Paddoc	20,0%	20,0%
Daily Spread	7,0%	7,0%
Source:	IPCC, 2006 chapter 10, Table 10A-4	IPCC, 2006 chapter 10, Table 10.22

$$N_{volatilization-MMS} = \sum_S \left[\sum_T \left[\left(N_{(T)} \bullet Nex_{(T)} \bullet MS_{(T,S)} \right) \bullet \left(\frac{Frac_{GasMS}}{100} \right)_{(T,S)} \right] \right]$$

Equation 3. N losses due to volatilization from manure management (IPCC 2006 chapter 10, Equation 10.26)

So as to complete the calculation of indirect N_2O emissions from manure management has been used Equation 4 (IPCC 2006 chapter 10, Equation 10.27), default factor of 0,01 kg N_2O-N · kg NH_3-N+NO_x-Nvolatilised^{-1} (IPCC, 2006, Chapter 11. table 11.3). These data means that N_2O indirect emissions are 0,313 kg N_2O · animal^{-1} · year^{-1}.

$$N_2O_{G(mm)} = \left(N_{volatilization-MMS} \bullet EF_4 \right) \bullet \frac{44}{28}$$

Equation 4. Indirect N_2O emissions due to volatilisation of N from manure management (IPCC 2006 chapter 10, Equation 10.27)

Global N_2O emissions associated to manure degradation are direct (1,26 kg N_2O animal^{-1} year^{-1}) plus indirect emissions (0,313 kg N_2O · animal^{-1} · year^{-1}), so 1,57 kg N_2O · animal^{-1} · year^{-1}, which means 468,86 kg $CO_{2\ eq}$ · animal^{-1} · year^{-1}, after application of conversion rate of 298 kg $CO_{2\ eq}$ · kg N_2O^{-1} (IPCC, 2007, 2.10.2). This means that, considering the average milk production in Western Europe of 6.000 kg · head^{-1} · year^{-1} (IPCC, 2006, Chapter 10. table 10.11), 0,08 kg $CO_{2\ eq}$ · kg of milk^{-1} comes from N_2O emissions associated to manure management.

N_2O emissions from decomposition of chemical fertilizers has been calculated considering the difference among total N_2O emissions, 0,46 kg $CO_{2\ eq}$ ·kg milk^{-1} and the N_2O associated to manure management, 0,08 kg $CO_{2\ eq}$ · kg milk^{-1}, so 0,38 kg $CO_{2\ eq}$ · kg milk^{-1} have been adopted as average in Europe for this thesis. This decision is adopted because the calculation of N_2O associated to chemical fertilizers is linked to factors determined by the type of food used to feed animals, the inputs to achieve it and its origin. There is no available data to define the impact associated to fertilizers used to feed dairy, so there is no way to allocate emissions from this origin to milk.

CO_2 emissions are produced before and after the farm gate. At the farm gate, CO_2 emissions are produced by tractors producing raw material for food, machinery for producing chemical fertilizers and the transportation of different inputs to the farm. For this gas and stage, it is also impossible to allocate correctly gases due to the lack of data, so 0,25 kg $CO_{2\ eq}$ · kg milk^{-1}, as calculated before, have been adopted. CO_2 produced at the farm gate comes from three activities, fuel consumption in tractors, electricity production and manufacturing (chemical fertilizers, seeds…) (Pirlo, 2002, 109). There is no data about each activity weight on emissions, so it has been considered one third of total emissions per origin.

CO_2 emissions after the farm gate need to be divided in stages or processes and for this purpose Bornmann (2011) and Thoma et al (2013) studies have been considered, because they divide emissions after farm gate in different stages. The distribution of these two researches in emissions and in percentages appear in Table 4.

Table 4. CO_2 emissions (kg CO_{2eq}·kg milk $^{-1}$) and the percentage in different stages of milk production after the farm gate, according to Bornmann (2011) and Thoma et al (2013).

	Bornman, 2011		Thoma et al, 2013	
Stages after farme gate	kg CO 2eq · kg milk -1	%	kg CO 2eq · kg milk -1	%
Milk processing	0,300	26,8%	0,147	22,9%
Packaging	0,110	9,8%	0,054	8,4%
Milk distribution	0,110	9,8%	0,203	31,7%
Retailing	0,260	23,2%	0,141	22,0%
Consumer phase	0,340	30,4%	0,095	14,9%
TOTAL	1,120		0,640	

The average of both results, and consequently, the average considered for the thesis is 24,86% for milk processing (including the transportation from the gate to the processing plant), 9,13% for packaging, 20,78% for milk distribution, 22,63% for retailing and 22,60% for consumer phase.

Considering CO_2 adopted emissions after the farm gate (0,32 $CO_{2\ eq}$ · kg milk^{-1}) and the percentages agreed before, emissions per stage are 0,08 $CO_{2\ eq}$ · kg milk^{-1} for Milk Processing; 0,03 $CO_{2\ eq}$ · kg milk^{-1} for Packaging, 0,07 $CO_{2\ eq}$ · kg milk^{-1} for Milk Distribution, 0,07 $CO_{2\ eq}$ · kg milk^{-1} for Retailing and 0,07 $CO_{2\ eq}$ · kg milk^{-1} in Consumer Stage. Distribution of CO_2 emissions is in last column of Figure 6.

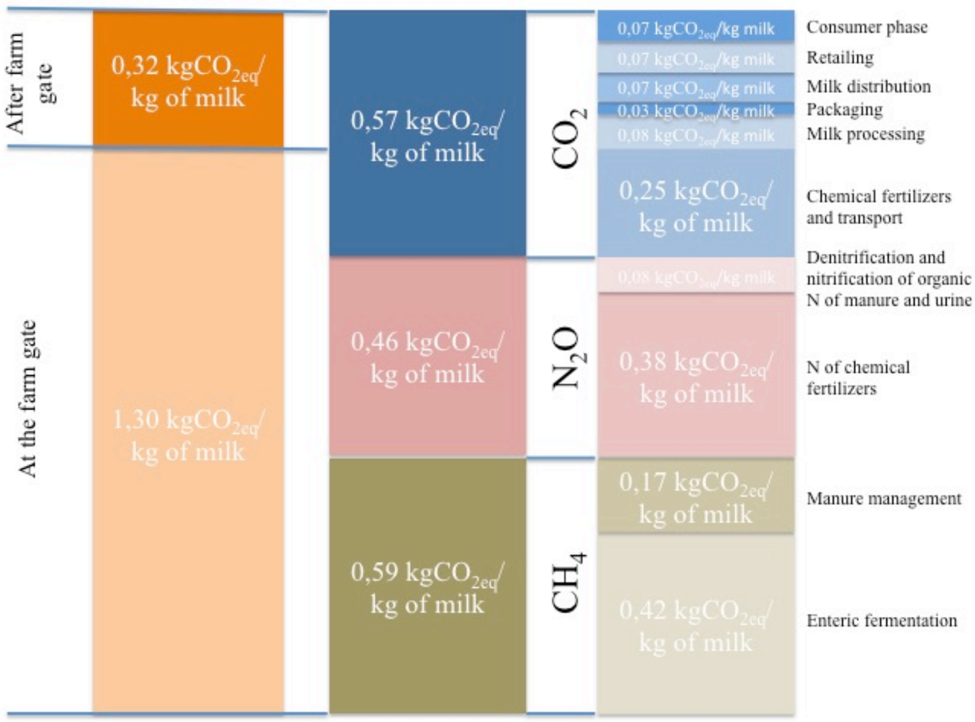

Figure 6. On the left, gross emissions ($CO_{2\ eq}$ · kg of milk^{-1}) per stages (at the farm gate and after the farm gate). On the middle, gross emissions (kg $CO_{2\ eq}$ · kg of milk^{-1}) per gases (CH_4, N_2O and CO_2). On the right, the allocation of gases according to the origin where these gases are emitted through the milk production chain.

3.2 GHG reduction potential

3.1.1 Methane reduction strategies

Methane from enteric fermentation has two main strategies to be reduced: milk yield per cow and dietary shifts. According to IPCC (2006, Chapter 10. table 10.11) ratios, the more milk production, the lower emission factor, so increasing dairy cows yield is one chance to reduce emissions per kg, as it is shown by data from North America (128 kg $CH_4 \cdot head^{-1} \cdot year^{-1}$ and production yield of 8.400 kg milk $\cdot$ $head^{-1} \cdot year^{-1}$) and Europe (117 kg $CH_4 \cdot head^{-1} \cdot year^{-1}$ and production yield of 6.000 kg milk $\cdot$ $head^{-1} \cdot year^{-1}$), which means emission factors of 0,3810 kg $CO_{2\,eq} \cdot$ kg $milk^{-1}$ in North America and 0,4875 kg $CO_{2\,eq} \cdot$ kg $milk^{-1}$ in Europe. For this thesis, this chance has not been considered as potential reduction strategy, because the yield of 6.000 litres $\cdot$ $cow^{-1} \cdot year^{-1}$ has been considered as reference for several calculations.

The second chance to reduce methane emissions associated to enteric fermentation is based on dietary shifts, concretely because of the type and amount of feed consumed (Gibbs, 2002, 299). According to TIER 2 method (IPCC 2006, Chapter 10. 10.31) the more important manageable factor affecting GHG emissions is the conversion factor (Ym), with a suggested factor of 6,5% + 1,0%, because Gross Energy Intake has been considered a fixed factor. Ym is affected by the type of food consumed by diary, and IPCC (2006, 10.32) states that when good food is available (i.e. high digestibility and high energy value) the lower bounds of the range should be used.

IPCC (2006, 10.32) suggests different Ym values depending on the availability of soy hulls or beet pulp, reducing the value from 8% to 11% in restricted feed intakes to 5% to 6% when measured in ad libitum intakes. It means that the access to certain food can reduce emission factor from 37,5% (from 8% to 5%) to 45,5% (from 11% to 6%), as emission factor is directly related to Ym.

For this thesis, the percentage adopted is the more conservative one, the result of reducing Ym factor from the lower limit for restricted feed intakes, 8%, to the higher limit for in ad libitum intakes, 6%, which means that 25% of emissions associated to enteric fermentation can be reduced with dietary shifts.

Methane emissions from manure management tend to be smaller than enteric emissions, with the most substantial emissions associated with confined animal management operations where manure is handled in liquid-based systems (IPCC, 2006. 10.7).

TIER 2 method for calculating methane emissions associated to manure management (IPCC 2006, Chapter 10. Equation 10.23) is based on some factors independent on management changes because depend on the animals, according to equation 5 (Daily Volatile Solid Excreted, $VS_{(T)}$; Maximum Methane producing capacity for manure produced by livestock category, $B_{o(T)}$), but there are two factors that are related to management issues. Both are affected by the type of manure management system, because Methane Conversion for each manure management system ($MCF_{s,k}$) and the fraction of livestock category with each Manure Management System ($MS_{(T,S,k)}$) are related to the farm management system.

EQUATION 10.23

CH_4 EMISSION FACTOR FROM MANURE MANAGEMENT

$$EF_{(T)} = \left(VS_{(T)} \bullet 365\right) \bullet \left[B_{o(T)} \bullet 0.67\, kg/m^3 \bullet \sum_{S,k} \frac{MCF_{S,k}}{100} \bullet MS_{(T,S,k)} \right]$$

Equation 5. CH_4 emission factor from manure management

(IPCC 2006 chapter 10, Equation 10.23)

According to IPCC 2006 (Chapter 10. Table 10.17), there are great differences in $MCF_{s,k}$ depending on the manure management system. Considering 19ºC as average temperature, management system order from the highest to the lowest MCF per system are Uncovered Anaerobic Lagoon (77%); Liquid/Slurry without natural crust cover (39%); Pit storage below animal confinements > 1 month (39%); Cattle deep bedding > 1 month (30%); Liquid/Slurry with natural crust cover (24%); Burned for fuel (10%); Solid storage (4%); Pit storage below animal confinements < 1 month (3%), Cattle deep bedding < 1 month (3%); Pasture/Range/Paddock (1,5%); Dry lot (1,5%); Composting (1%); Daily spread (0,5%) or Aerobic Treatment (0%).

According to IPCC 2006 (Chapter 10. Table 10A-4), MS for Western Europe is 35,7% Liquid/Slurry; 36,8% Solid Storage; 20,0% Pasture/Range/Paddock; 7,0% Daily Spread and 0,5% Others. The sum of both factors product gives as a result 0,1573.

In order to calculate potential reduction factors, it is proposed to reduce the fraction of cattle with Liquid/Slurry systems (MS) in 5% for being the highest contributors in terms of Conversion for each Manure Management System (MCF), and increasing the percentage of cattle with Solid Storage System (+1,5%), Pasture/Range/Paddock (+1,5%); Daily Spread (+2%). With this new MS distribution, the result of both factors product gives as a result 0,138725, so the reduction potential linked to Methane produced in Manure Management is 11,81%, because it is considered that MS is the only factor changing. This scenario is proposed in general terms, but it is clear that at farm level, a change in manure management system could have a deeper impact on terms of emissions.

With these two strategies, CH_4 total emissions could be reduced from 0,59 kg $CO_{2\ eq} \cdot$ kg milk^{-1} to 0,47 kg $CO_{2\ eq} \cdot$ kg milk^{-1}, which means a reduction of 21,22%.

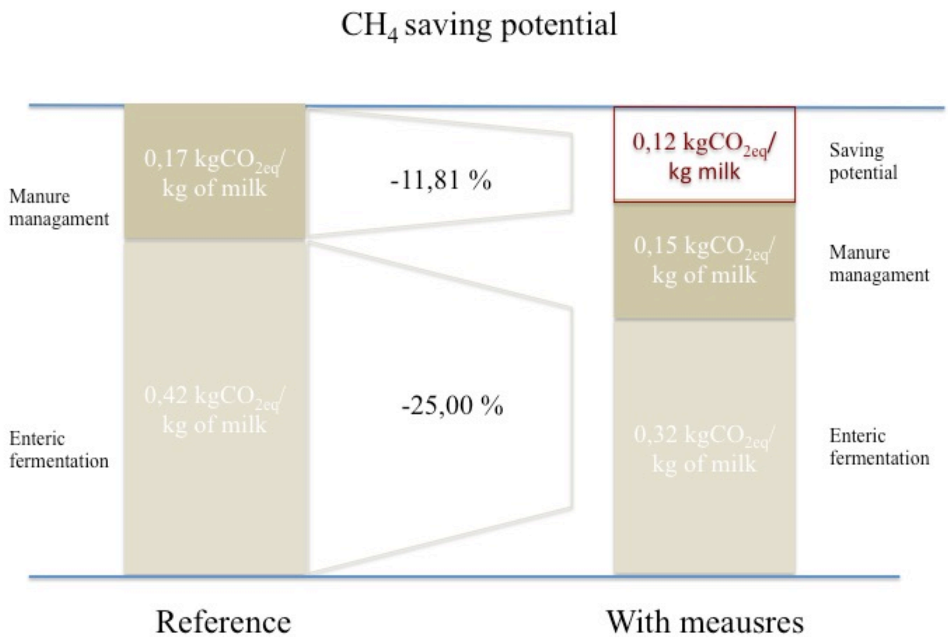

Figure 7. CH_4 reduction potential per stage in milk production cycle ($CO_{2\ eq} \cdot$ kg of milk[1]). On the left, greenhouse gases emitted in each stage where CH_4 is produced. On the on the middle, reduction potential in percentage per stage. On the right, greenhouse gases emitted if proposed measures are considered and saving potential for CH_4.

3.1.2 Nitrous Oxide reduction strategies

Nitrous oxide emissions from manure management vary significantly between the types of management system used (IPCC, 2006. 10.7). N_2O reduction potential associated to Manure Management has been calculated using equations 1 and 3, modelling the reduction according to shifts in manure management systems. It has been considered the same alternative distribution of systems that was considered in 3.2.1 (Liquid/Slurry systems -5%; Solid Storage System +1,5%, Pasture/Range/Paddock +1,5%; Daily Spread +2%). Considering this new manure management system distribution, N_2O direct emissions rises from 1,26 kg $N_2O \cdot animal^{-1} \cdot year^{-1}$ to 1,28 kg $N_2O \cdot animal^{-1} \cdot year^{-1}$, according to equation 1.

For indirect emissions from manure management, it means reducing the factor from 0,31336 kg $N_2O \cdot animal^{-1} \cdot year^{-1}$ to 0,30169 kg $N_2O \cdot animal^{-1} \cdot year^{-1}$, according to equation 4. In total, N_2O emissions from manure management would increase the emissions from 1,5734 kg $N_2O \cdot animal^{-1} \cdot year^{-1}$ to 1,5823kg $N_2O \cdot animal^{-1} \cdot year^{-1}$, due to the proposed changes in manure management systems distribution.

Considering the equivalence of $CO_{2\,eq}$ per N_2O and the yield of (IPCC, 2006, Chapter 10. table 10.11) kg milk $\cdot animal^{-1} \cdot year^{-1}$, it means that proposed changes would increase the emissions from 0,07814 kg $CO_{2\,eq} \cdot$ kg $milk^{-1}$ to 0,07859 kg $CO_{2\,eq} \cdot$ kg $milk^{-1}$, so N_2O produced in Manure Management would increase in 0,57%.

N_2O coming from chemical fertilizers has improvement potential according to its origin. Chemical fertilizers based on N produce GHG in the production process (heat) and because the formulation of fertilizers, based on ammonium nitrate for which ammonia and nitric acid are needed (Ecofys, 2015, 3). According to Ecofys (2015, 6), European fertilizers plants are the most efficient plants in the world, but there are still improvements to be adopted by the industry and by the fertilizers users. Summarized improvements potential could reduce energy demand and so emissions from current 35 GJ $\cdot tonne^{-1}$ ammonia for current plants to 32 GJ $\cdot tonne^{-1}$ ammonia with improvements in existing plants, or 25 GJ $\cdot tonne^{-1}$ ammonia in new plants, so savings from 8,57% to 28,57% are possible. For this thesis, it is supposed that farmers can demand products with a lower impact in terms of emissions for boosting improvements in current plants, and even promoting the construction of new effective plants, so a potential savings of 10% has been considered.

With these two strategies, N_2O total emissions could be reduced from 0,47 kg $CO_{2\ eq} \cdot$ kg milk^{-1} to 0,42 kg $CO_{2\ eq} \cdot$ kg milk^{-1}, which means a reduction of 8,19%.

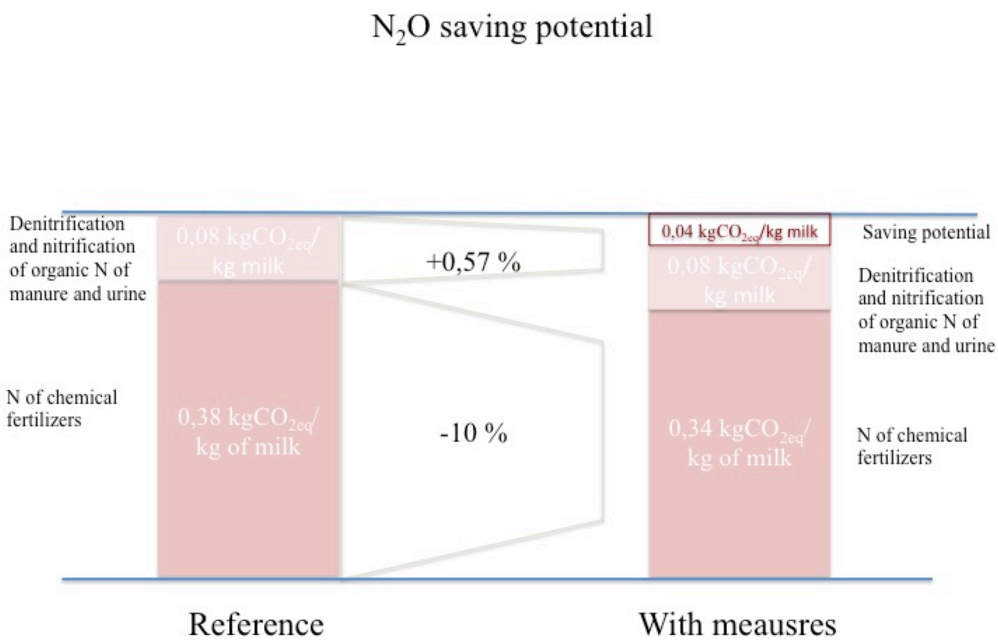

Figure 8. N_2O reduction potential per stage in milk production cycle ($CO_{2\ eq} \cdot$ kg of milk^{-1}). On the left, greenhouse gases emitted in each stage where N_2O is produced. On the on the middle, reduction potential in percentage per stage. On the right, greenhouse gases emitted if proposed measures are considered and saving potential for N_2O.

3.1.3 CO_2 reduction strategies

CO_2 at the farm gate is emitted on the combustion of fossil fuels used for moving tractors, production electricity and manufacturing as chemical fertilizers, seeds, etc (Pirlo, 2002, 109). It has been considered that emissions are distributed at 33% for each origin (Tractors operation, Electricity consumed in the farm and CO_2 from inputs).

Fuel consumption, and so emissions, associated to tractors are affected by technology improvements and driving practices (Biggs, 2013). It has not been evaluated the potential impact of purchasing new tractors. Instead of that, it has been analysed the average potential fuel consumption reduction of adapting driving techniques (10-20% savings); adapting implements (5-8% savings), adapting implement settings (up to 30% savings); adapting tyre pressures (5-10% savings); weight management (5-8% savings) and engine maintenance (5-10% savings) (Intelligent Energy Europe, 2013, 4). Considering the average of each action and a multi action application, it has been considered a potential saving of 45,96%. As emissions from tractors have been considered one third of CO_2 emissions at the farm gate, the impact of these measures is 15,32%.

Electricity consumption at the farm gate weights, according to this thesis hypothesis, one third of the CO_2 emissions for this stage. Electricity is consumed in Milk Cooling (40%), Water Heating (28%), Milk Machine (18%), Water Pump (8%), Automatic Scrapes (4%) and Lighting (3%) (Upton J, 2014, 4978).

Milk cooling systems use electricity to reduce milk temperature from 35ºC to 4ºC in order to keep it in optimum conditions in the farm, before milk is collected by milk industry. Energy reduction is based on pre-cooling systems based on plate coolers, where milk and water are put together indirectly through a metal surface. This equipment can reduce energy demand from 20% to 50% (De Laval). It has been considered that saving potential is the minimum of the range, 20%, because its application depends on a number of factors that make it difficult to obtain maximum yields.

Water heating systems use energy to raise water temperature. According to De Laval, it is possible to save from 20% to 50% of energy demanded for heating water, using pre-cooling systems that will use milk heat to pre-heat water used on the farm. Water heating can also reduce its emissions contributions by using solar panels. In that case, emission reduction is 100%. In this case, it has been used a saving potential of the average suggested by De Laval, 35%, as there are chances as solar systems that can compensate the inconveniences of pre-cooling systems.

Milking machine energy consumption is associated to pumps and internal equipment. According to De Laval, there is a saving potential of 20% in milk pumps, so this figure is considered for the study. Water pumps consume energy to extract groundwater or to elevate the pressure to water used in the farm. There are chances to reduce energy consumption in pumps, using variator modules. Despite there are chances to increase saving, it has been considered the saving potential suggested by De Laval for milking machines, 20%.

Automatic scrapes consume energy for moving scrapes within the farm, in order to eliminate manure. This equipment uses motors to move scrapes. It has been considered no chance to reduce, because not all farms have scrapes installed, so any saving for this equipment can not be applied on average. Lighting is the last electricity consumption considered in the farm. Last advances on lighting systems can reduce energy consumption more than 20% if traditional fluorescent lamps are substituted by LED. It has been considered 20% of saving potential. Considering each action energy saving potential, it has been considered a potential average saving of 23,66%. As emissions from tractors have been considered one third of CO_2 emissions at the farm gate, the impact of these measures is 7,89%.

Last third of CO_2 emitted at the farm gate is associated to manufacturing products as fertilizers, seeds, etc. According to Ecofys (2015), and the considerations adopted for Nitrous Oxide reduction strategy related to fertilizers, it has been considered 10% of potential savings. As emissions from manufacturing have been considered one third of CO_2 emissions at the farm gate, the impact of these measures is 3,33%. In total, saving potential of CO_2 at the farm gate has been considered to be 26,54%.

Energy consumption in milk processing industry has been associated to electricity in this thesis. According to Tengfang (2009, 1), energy used in fluid milk processing industry can be estimated between 0,2 and 12,6 $MJ \cdot kg$ fluid $milk^{-1}$ (0,055-3,5 $kWh \cdot kg$ fluid $milk^{-1}$). Considering the average emission rate for electricity in Europe of 275,9 g $CO_2 \cdot kWh^{-1}$ (European Environment Agency, 2014), it means that emissions associated to energy consumption for milk processing industry is between 0,01533-0,96565 kg $CO_2 \cdot$ kg fluid $milk^{-1}$.

In the general framework of emissions for this thesis, it has been considered 0,0794 kg $CO_2 \cdot$ kg $milk^{-1}$, so it is clear that there are improvements chances for cutting down the emission rate, despite of being in the lowest part of the emissions range. It has been considered that diary farmers can boost the adoption of efficiency measures in milk processing sector, so it has been considered a potential saving of 10%, from 0,0794 kg $CO_2 \cdot$ kg $milk^{-1}$ to 0,0715 kg $CO_2 \cdot$ kg $milk^{-1}$, which is within the proposed range by Tengfang (2009) research.

Emissions associated to packaging are related to the material used to package milk and the process of packaging According to Minghui (2011), there are small differences in terms of impact of using the two more common materials for packaging, Paper-Polyethylene-Aluminium (PA-PE-Al) laminate and polyethylene, with differences on each material lifecycle but with similar behaviour in terms of environmental impact along the whole process. For this reason, it has not been considered any reduction impact in terms of greenhouse emissions in this stage for this thesis.

Emissions related to milk distribution are related to the transportations routes of milk among different stages. Milk is transported from the farm to the dairy industry, and from the diary industry to sales point. In some cases there are intermediate steps, with logistic centres between industry and final sale point.

The analysis of food miles indicator conducted by Torquati (2014) indicates that different milks have different impact in terms of GHG emissions depending on the origin of milk (national, regional and local). Each milk origin has an impact associated to the distance that milk is transported, with average of 0,1146 kg $CO_2 \cdot$ kg milk^{-1} for national milk, 0,0486 kg $CO_2 \cdot$ kg milk^{-1} for regional milk and 0,067 kg $CO_2 \cdot$ kg milk^{-1} for local milk. The average emission factor for the three milk origins is 0,0767 kg $CO_2 \cdot$ kg milk^{-1}.The emission factor agreed on the thesis, 0,0664 kg $CO_2 \cdot$ kg milk^{-1}, is in line with the data for local milk emissions for Italian milk.

The saving potential for milk distribution has been calculated according to percentages of reduction potential from the main emission factors suggested for the three milk origins suggested by Torquati (2014) and the decision of choosing a milk produced in the region of consumer. In this regard, reduction potential is 36,64%.

Retailing and consumer phase are stages that cannot be conditioned by milk sector. Retailing depends on the emissions associated to final sales point, with differences in energy consumption in supermarkets, local shops, big retail chains, etc. Consumer phase is related to the emissions associated to consumer decisions in terms of milk consumption. Aspects such as milk transportation from sales point to houses, efficiency of refrigerators and the decision of recycling containers have direct impact on the increase of energy emissions. Both decisions are not considered as reduction potential factors, so 0% has been considered. With these strategies, CO_2 total emissions could be reduced from 0,57 kg $CO_{2\ eq} \cdot$ kg milk^{-1} to 0,47 kg $CO_{2\ eq} \cdot$ kg milk^{-1}, which means a reduction of 17,28%.

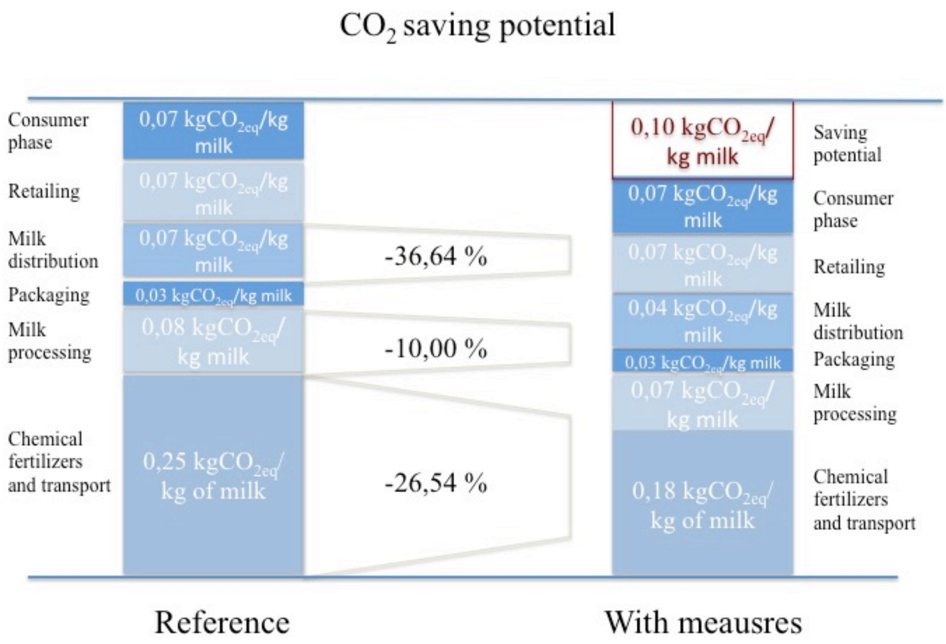

Figure 9. CO_2 reduction potential per stage in milk production cycle ($CO_{2\ eq} \cdot$ kg of milk^{-1}). On the left, greenhouse gases emitted in each stage where CO_2 is produced. On the on the middle, reduction potential in percentage per stage. On the right, greenhouse gases emitted if proposed measures are considered and saving potential for CO_2.

3.1.4 Total reduction potential

According to previous strategies, GHG emissions potential for milk production can be reduced from 1,62 kg $CO_{2\ eq} \cdot$ kg milk^{-1} to 1,36 kg $CO_{2\ eq} \cdot$ kg milk^{-1}, which means a reduction potential of 0,26 kg $CO_{2\ eq} \cdot$ kg milk^{-1} or 16,18% less emissions in milk production, with different potential reduction according to stages of the milk production cycle (Figure 7).

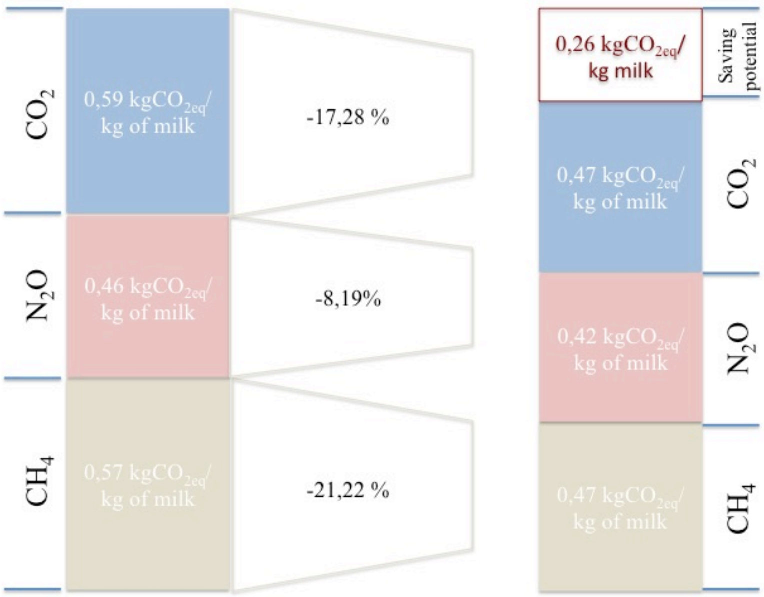

Figure 10. Reduction potential per gas in milk production cycle ($CO_{2\ eq} \cdot$ kg of milk^{-1}). On the left, greenhouse gases emitted in milk production. On the on the middle, reduction potential in percentage per stage. On the right, greenhouse gases emitted if proposed measures are considered and total saving potential.

3.3 Consumers preference

200 questionnaires were received during the two months that survey was open to be answered. All the answers can be seen in Appendix 2 data and Appendix 3 with results charts.

First group of questions were about personal data to know the age, gender and precedence of participants. 141 questionnaires were sent by people living in Spain and 51 by people living in Finland. 8 questionnaires were completed by people living in other countries. People answering the survey live in cities with a population between 50.001 and 100.000 inhabitants (37,5%). 49% of men and 51% of women took part on the survey. The most common age range was between 25 and 35 years old (35,5%) (Table 5).

Table 5. The distribution of gender, age and precedence of participants in the questionnaire.

QUESTION	Where do you live?	Inhabitants of your city:	Gender	Age	QUESTION
ANSWER	Spain	Less than 100	Male	<25	ANSWER
Number	141	3	98	33	Number
% total	**70,50%**	**1,50%**	**49,00%**	**16,50%**	**% total**
ANSWER	Finland	101-500	Female	25-35	ANSWER
Number	51	3	102	71	Number
% total	**25,50%**	**1,50%**	**51,00%**	**35,50%**	**% total**
ANSWER	Others	501 - 1.000		36-45	ANSWER
Number	8	7		60	Number
% total	**4,00%**	**3,50%**		**30,00%**	**% total**
ANSWER		1.001 - 5.000		46-55	ANSWER
Number		7		24	Number
% total		**3,50%**		**12,00%**	**% total**
ANSWER		5.000 - 20.000		56-65	ANSWER
Number		29		9	Number
% total		**14,50%**		**4,50%**	**% total**
ANSWER		20.001 - 50.000		>65	ANSWER
Number		25		3	Number
% total		**12,50%**		**1,50%**	**% total**
ANSWER		50.001 - 100.000			ANSWER
Number		75			Number
% total		**37,50%**			**% total**
ANSWER		More than 100.001			ANSWER
Number		51			Number
% total		**25,50%**			**% total**

There were questions about family members in terms of children. 44,0% of people who answered the survey had children, with 2 children under 18 years old living at home as the most common answer (Table 6).

Table 6. Answers about children aspects of participants

QUESTION	Do you have children?	If yes… how many of them are Living at home? [Under 18 years old]	If yes… how many of them are Living at home? [Over 18 years old]	QUESTION
ANSWER	Yes	0	0	ANSWER
Number	88	19	75	Number
% total	**44,00%**	**21,59%**	**85,23%**	**% total**
ANSWER	No	1	1	ANSWER
Number	112	27	8	Number
% total	**56,00%**	**30,68%**	**9,09%**	**% total**
ANSWER		2	2	ANSWER
Number		37	4	Number
% total		**42,05%**	**4,55%**	**% total**
ANSWER		3	3	ANSWER
Number		4	1	Number
% total		**4,55%**	**1,14%**	**% total**
ANSWER		4 or more	4 or more	ANSWER
Number		1	0	Number
% total		**1,14%**	**0,00%**	**% total**

There was a group of questions about "Milk Consumption Habits" of participants. First ones asked about the frequency of milk consumption and amount of milk consumed by participants and their family. 82,0% of people consume milk every day. 26,5% of the participants declare a consumption of 0,1 – 0,5 litres · week^{-1} for themselves and 27,5% more than 4 litres · week^{-1} for all the family members (Table 7).

Table 7. Answers for questions about frequency and amount of milk consumed

QUESTION	How often do you / your family consume milk?	How much milk do you and your family consume per week? (litres)		QUESTION
		Only you	All your family	
ANSWER	Every day	0	1	ANSWER
Number	164	14	8	Number
% total	**82,00%**	**7,00%**	**4,00%**	**% total**
ANSWER	4-6 days per week	0,1-0,5 l	0,1-0,5 l	ANSWER
Number	16	53	25	Number
% total	**8,00%**	**26,50%**	**12,50%**	**% total**
ANSWER	1-3 days per week	0,6 - 1 l	0,6 - 1 l	ANSWER
Number	5	37	25	Number
% total	**2,50%**	**18,50%**	**12,50%**	**% total**
ANSWER	Never or rarely	1,1 - 1,5 l	1,1 - 1,5 l	ANSWER
Number	15	32	18	Number
% total	**7,50%**	**16,00%**	**9,00%**	**% total**
ANSWER		1,6 - 2 l	1,6 - 2 l	ANSWER
Number		25	23	Number
% total		**12,50%**	**11,50%**	**% total**
ANSWER		2,1 - 3 l	2,1 - 3 l	ANSWER
Number		21	20	Number
% total		**10,50%**	**10,00%**	**% total**
ANSWER		3,1 - 4 l	3,1 - 4 l	ANSWER
Number		13	26	Number
% total		**6,50%**	**13,00%**	**% total**
ANSWER		More than 4,1 l	More than 4,1 l	ANSWER
Number		5	55	Number
% total		**2,50%**	**27,50%**	**% total**

Last questions about milk consumption habits asked about the fidelity of respondents to milk brand and the reasons to select the brand consumed. 49,5% of people consume always (90%-100% of times) the same brand of milk, with "Price" (124), "Quality" (104) and "Origin. Produced in my country" as the most common three main reasons to choose milk brand (Table 8).

Table 8. Answers for questions about fidelity to milk brand and reasons to choose the brand

QUESTION	Do you always buy the same brand?	Reasons to choose the brand (Select up to 3 options, 1 (the main reason), 2 (the second reason) and 3 (the third reason)										QUESTION
		Price	Origin. Produced in my country	Origin. Produced closed to my living area	Quality	Flavour	Environmantal labels	Container design	Media advertisement	Brand confidence	Others	
ANSWER	Yes, 90%-100% of times	1	1	1	1	1	1	1	1	1	1	ANSWER
Number	99	58	27	19	41	24	4	0	0	14	8	Number
% total	**49,50%**	**46,77%**	**29,67%**	**40,43%**	**39,42%**	**29,63%**	**17,39%**	**0,00%**	**0,00%**	**21,88%**	**44,44%**	**% total**
ANSWER	Almost, 50%-89% of times	2	2	2	2	2	2	2	2	2	2	ANSWER
Number	64	31	44	17	42	31	6	4	1	12	1	Number
% total	**32,00%**	**25,00%**	**48,35%**	**36,17%**	**40,38%**	**38,27%**	**26,09%**	**50,00%**	**33,33%**	**18,75%**	**5,56%**	**% total**
ANSWER	I try to do it, but neccesarily, 25%49% of times	3	3	3	3	3	3	3	3	3	3	ANSWER
Number	17	35	20	11	21	26	13	4	2	38	9	Number
% total	**8,50%**	**28,23%**	**21,98%**	**23,40%**	**20,19%**	**32,10%**	**56,52%**	**50,00%**	**66,67%**	**59,38%**	**50,00%**	**% total**
ANSWER	No, I don't pay attention to it, 0% - 24% of times											ANSWER
Number	20											Number
% total	**10,00%**											**% total**

There was a group of questions about "Milk Sector Environment Impact. Fist questions of this group asked about how respondents identify environmental impact of milk and what are the stages were participants identify more important impacts. 42,5% of people consider milk has a "Medium impact" on environment, with "Animal feed production" (62), "Dairy treatment" (37) and "Transport to shops" (25) as the phases where more people identify the highest impact (Table 9).

Table 9. Answers for questions about interpretation of milk production environment and stages were main impacts are identified

QUESTION	What impact do you think milk production has for environment?	In what phase of milk production you think are the biggest impacts to environment							QUESTION
		Animal feed production	Farm	Transport to diary	Dairy treatment	Transort to shops	Maintenance of milk in shops	Consumption by final consumers	
ANSWER	Very low impact	1	1	1	1	1	1	1	ANSWER
Number	14	62	29	13	37	25	11	23	Number
% total	**7,00%**	**31,00%**	**14,50%**	**6,50%**	**18,50%**	**12,50%**	**5,50%**	**11,50%**	**% total**
ANSWER	Low impact	2	2	2	2	2	2	2	ANSWER
Number	37	46	29	35	26	38	13	13	Number
% total	**18,50%**	**23,00%**	**14,50%**	**17,50%**	**13,00%**	**19,00%**	**6,50%**	**6,50%**	**% total**
ANSWER	Medium impact	3	3	3	3	3	3	3	ANSWER
Number	85	9	36	50	42	37	16	10	Number
% total	**42,50%**	**4,50%**	**18,00%**	**25,00%**	**21,00%**	**18,50%**	**8,00%**	**5,00%**	**% total**
ANSWER	High impact	4	4	4	4	4	4	4	ANSWER
Number	54	23	13	45	38	36	22	23	Number
% total	**27,00%**	**11,50%**	**6,50%**	**22,50%**	**19,00%**	**18,00%**	**11,00%**	**11,50%**	**% total**
ANSWER	Very high impact	5	5	5	5	5	5	5	ANSWER
Number	10	12	26	33	36	34	36	23	Number
% total	**5,00%**	**6,00%**	**13,00%**	**16,50%**	**18,00%**	**17,00%**	**18,00%**	**11,50%**	**% total**
ANSWER		6	6	6	6	6	6	6	ANSWER
Number		16	39	20	11	23	66	25	Number
% total		**8,00%**	**19,50%**	**10,00%**	**5,50%**	**11,50%**	**33,00%**	**12,50%**	**% total**
ANSWER		7	7	7	7	7	7	7	ANSWER
Number		32	28	4	10	7	36	83	Number
% total		**16,00%**	**14,00%**	**2,00%**	**5,00%**	**3,50%**	**18,00%**	**41,50%**	**% total**

Next questions asked about the main negative impacts that participants identified for milk production. The most important three impacts on the environment identified by people are "Resource consumption" (128), "Climate change" (92) and "Land use" (80). (Table 10).

Table 10. Answers for questions about environmental impacts associated to milk production

QUESTION	What type of negative impacts do you associate more to milk production? (Select up to 3 options, 1 (the main impact), 2 (the second impact) and 3 (the third impact))										QUESTION
	Resource consumption	Land use	Climate change	Ozone layer depletion	Human toxicity	Toxicity for environment	Photo-oxidant formation	Acidification	Euthropication	Others	
ANSWER	1	1	1	1	1	1	1	1	1	11	ANSWER
Number	59	14	30	24	9	21	9	11	10	5	Number
% total	**46,09%**	**17,50%**	**32,61%**	**39,34%**	**27,27%**	**28,77%**	**39,13%**	**45,83%**	**26,32%**	**83,33%**	**% total**
ANSWER	2	2	2	2	2	2	2	2	2	12	ANSWER
Number	35	41	31	15	13	24	6	8	12	0	Number
% total	**27,34%**	**51,25%**	**33,70%**	**24,59%**	**39,39%**	**32,88%**	**26,09%**	**33,33%**	**31,58%**	**0,00%**	**% total**
ANSWER	3	3	3	3	3	3	3	3	3	3	ANSWER
Number	34	25	31	22	11	28	8	5	16	1	Number
% total	**26,56%**	**31,25%**	**33,70%**	**36,07%**	**33,33%**	**38,36%**	**34,78%**	**20,83%**	**42,11%**	**16,67%**	**% total**

There were questions about "Factors to Change Purchasing. First question was about the chances for changing normal brand, and then it was asked about the factors that would make people change their normal brand. 52,0% of people could change their normal milk brand for some other, 22,5% would probably change the milk brand and 19,5% don't have any preference. Only 6,0% of people would not change their milk brand. "Quality" (113), "Lower price" (100) and "Origin. Produced in my region" (98) are the most common three main declared reasons to change the milk brand (Table 11).

Table 11. Answers for questions about chances to change normal milk brand and factors that would make change this decision

QUESTION	Would you change your normal brand for some other?	What factors would you make to change your mind about milk brand? Select up to 3 options, 1 (the main factor), 2 (the second factor) and 3 (the third factor)											QUESTION
		Lower price	Origin. Produced in my country	Origin. Produced in my region	Quality	Environ mental labels	Less energy consumption on in the production	Container design	Media advertisement	Brand confidence	Social Corporation Responsibility	Others	
ANSWER	Not, never	1	1	1	1	1	1	1	1	1	1	1	ANSWER
Number	12	53	13	26	61	14	3	0	1	4	15	7	Number
% total	**6,00%**	**53,00%**	**22,41%**	**26,53%**	**53,98%**	**29,17%**	**7,89%**	**0,00%**	**33,33%**	**12,90%**	**26,79%**	**63,64%**	**% total**
ANSWER	It could be	2	2	2	2	2	2	2	2	2	2	2	ANSWER
Number	104	21	27	37	36	11	23	1	1	13	15	2	Number
% total	**52,00%**	**21,00%**	**46,55%**	**37,76%**	**31,86%**	**22,92%**	**60,53%**	**11,11%**	**33,33%**	**41,94%**	**26,79%**	**18,18%**	**% total**
ANSWER	Probably	3	3	3	3	3	3	3	3	3	3	3	ANSWER
Number	45	26	18	35	16	23	12	8	1	14	26	2	Number
% total	**22,50%**	**26,00%**	**31,03%**	**35,71%**	**14,16%**	**47,92%**	**31,58%**	**88,89%**	**33,33%**	**45,16%**	**46,43%**	**18,18%**	**% total**
ANSWER	I don't have any preference												ANSWER
Number	39												Number
% total	**19,50%**												**% total**

Next questions asked about factors that would make participants pay an extra cost for milk. “Quality” (136), “Origin. Produced in my region” (117) and “Flavour” (73) are the three more repeated answers (Table 12).

Table 12. Answers for questions about factors that would make participants pay an extra cost for milk

QUESTION	Would you pay an extra cost for some of these reasons? Select up to 3 options, 1 (the main reason to pay an extra cost), 2 (the second reason) and 3 (the third reason)											QUESTION
	Origin. Produced in my country	Origin. Produced in my region	Quality	Flavour	Environ mental labels	Less energy consumption in the production	Container design	Media advertisement	Brand confidence	Social Corporation Responsibility	Others	
ANSWER	1	1	1	1	1	1	1	1	1	1	1	ANSWER
Number	20	51	67	22	14	4	0	0	0	15	3	Number
% total	**29,85%**	**43,59%**	**49,26%**	**30,14%**	**25,93%**	**8,16%**	**0,00%**	**0,00%**	**0,00%**	**27,78%**	**50,00%**	**% total**
ANSWER	2	2	2	2	2	2	2	2	2	2	2	ANSWER
Number	24	33	39	36	18	23	1	0	4	13	1	Number
% total	**35,82%**	**28,21%**	**28,68%**	**49,32%**	**33,33%**	**46,94%**	**25,00%**	**0,00%**	**22,22%**	**24,07%**	**16,67%**	**% total**
ANSWER	3	3	3	3	3	3	3	3	3	3	3	ANSWER
Number	23	33	30	15	22	22	3	1	14	26	2	Number
% total	**34,33%**	**28,21%**	**22,06%**	**20,55%**	**40,74%**	**44,90%**	**75,00%**	**100,00%**	**77,78%**	**48,15%**	**33,33%**	**% total**

There was a question about the extra price that participants are willing to pay, according to the factors that they selected before as the main reasons to change their normal milk brand. 49,5% of people would pay more than 7% of normal price for a milk offering them the first factor to change their usual brand selection (Table 13).

Table 13. Answers for question about extra cost willing to pay

QUESTION	According to your selection in "extra cost" question, how much would you extra pay?			QUESTION
	Answer 1	Answer 2	Answer 3	
ANSWER	0	0	0	ANSWER
Number	10	12	22	Number
% total	**5,00%**	**6,00%**	**11,00%**	**% total**
ANSWER	1%-3%	1%-3%	1%-3%	ANSWER
Number	44	65	66	Number
% total	**22,00%**	**32,50%**	**33,00%**	**% total**
ANSWER	4%-6%	4%-6%	4%-6%	ANSWER
Number	47	44	36	Number
% total	**23,50%**	**22,00%**	**18,00%**	**% total**
ANSWER	7%-10%	7%-10%	7%-10%	ANSWER
Number	41	37	31	Number
% total	**20,50%**	**18,50%**	**15,50%**	**% total**
ANSWER	11%-15%	11%-15%	11%-15%	ANSWER
Number	23	16	17	Number
% total	**11,50%**	**8,00%**	**8,50%**	**% total**
ANSWER	16%-20%	16%-20%	16%-20%	ANSWER
Number	17	12	14	Number
% total	**8,50%**	**6,00%**	**7,00%**	**% total**
ANSWER	21%-30%	21%-30%	21%-30%	ANSWER
Number	9	5	9	Number
% total	**4,50%**	**2,50%**	**4,50%**	**% total**
ANSWER	31%-40%	31%-40%	31%-40%	ANSWER
Number	2	5	1	Number
% total	**1,00%**	**2,50%**	**0,50%**	**% total**
ANSWER	41%-50%	41%-50%	41%-50%	ANSWER
Number	5	3	3	Number
% total	**2,50%**	**1,50%**	**1,50%**	**% total**
ANSWER	More than 51%	More than 51%	More than 51%	ANSWER
Number	2	1	1	Number
% total	**1,00%**	**0,50%**	**0,50%**	**% total**

4. Discussion

4.1 LCA for milk sector analysis

The method of life cycle assessment is valid for conducting a general study for milk sector, when the goal of it is obtaining a general framework of what gases are emitted along the life cycle and in what stages of the lifecycle are produced. The results obtained by LCA method allow identifying opportunities to improve environmental performance as well as optimising products and process according to its environmental impact, so it has been useful for the project aim of identifying where milk production has environmental impact and what the best strategies are for lessen it.

The conducted analysis has been done in a general framework of milk sector at European level, but it can be conducted in a more specific basis if the interest is focussed on analysing environmental impact and strategies to reduce it at national, regional, local or even at farm level.

In terms of stage definition along the product lifecycle, the selection of “from cradle to grave” process and the stages defined allow the identification of different strategies depending on the analysed step of the process along the production chain.

4.2 Greenhouse gases analysis

Measuring the environmental impact in terms of Greenhouse gases emissions is adequate for comparison because it allows transforming different gases emissions into a unique and comparable functional unit, kg $CO_{2\ eq}\cdot$ kg of milk^{-1} for this thesis. Moreover, Greenhouse gases production is a wide known impact for general public and there is a general public concern about this impact, so its analysis can attract the interest of more people than other impacts less known.

Most of gases are produced at-farm-gate (80,27%), so the biggest responsibility for reducing the impact lies down on the stakeholders involved in those stages, mainly farmers and producers of inputs for the milk production chain.

Farmers are directly responsible of four actions related to GHG emissions. Enteric fermentation, manure management, transport in the farm and electricity consumed in the farm. These stages represent, according to thesis data, 0,84 kg $CO_{2\ eq}\cdot$ kg of milk^{-1}.

Farmers must attend to dietary issues if they want to reduce emissions associated to Enteric Fermentation. Any change on farm feed can affect to milk yield production, so it is important to measure the impact of both consequences and selecting an adequate solution.

One other issue that farmers must attend to reduce milk environmental impact is the manure management system used in the farm, which will affect to CH_4 and N_2O emissions. There are some alternatives to manage dung, with wide differences in terms of impact, so it is clear that a management decision can affect positively to the target of reducing emissions, even lessen it to cero if a farmer selects a system with no emissions associated (Aerobic Treatment) or with very low impact (Composting or Dry lot). This chances for individual farmers may reduce at almost zero the emissions associated to manure management in one farm, but it is not applicable for the whole industry, so it has been considered a trend on the adoption of alternatives with lower impact in terms of GHG emissions for this thesis.

The other GHG emission directly associated to farmers is CO_2 from the use of machinery and electricity in the farm. There are alternatives at general level that are related to the adoption of more sustainable and efficient use of tractors, and the reduction of the environmental impact from electricity consumption. Once again, the alternatives in a general framework are less ambitious than those actions that each farmer can adopt, with the chance of reducing the impact of electricity consumption to cero, if it is consumed zero emissions electricity.

The proposed measures to reduce GHG emissions associated to farmers activity mean that it can be reduced from 0,84 kg $CO_{2\ eq}\cdot$ kg of milk^{-1} to 0,67 kg $CO_{2\ eq}\cdot$ kg of milk^{-1}, which means a reduction of 20,25% emissions that farmers as general sector at European level can achieve with the proposed measures.

This reduction is in line with European general targets, so the adoption of these measures will point farmers as active elements in the reduction emission policy. This fact implies that it can be used to promote and value actions adopted by farmers in the reduction of environmental impacts, and so, a good positioning in the market because they respond to consumers demand of lessen human activities impact.

Another stakeholder in the milk production chain is the fertilizer producer. The emissions associated to them are related to the ammonia used in plants and its impact in N_2O emissions from chemical fertilizers and the CO_2 emitted in the production plants associated to its productive process and its transport to farms. These stages represent, according to thesis data, 0,46 kg $CO_{2\,eq}$· kg of milk^{-1}.

Farmers have an indirect chance of reducing the impact associated to this source, through the selection of more efficient and environmental friendly inputs. A progressive shift to chemical fertilizers with lower environmental impact, produced in more efficient plants and made close to farms are strategies that individual farmers and the whole industry can promote to cut down the impact of fertilizers consumption, from 0,46 kg $CO_{2\,eq}$· kg of milk^{-1} to 0,40 kg $CO_{2\,eq}$· kg of milk^{-1}, which means a reduction of 12,99% emissions that farmers as general sector at European level can achieve indirectly increasing the demand of more sustainable inputs.

The last stakeholder with chances of reducing its impact in the milk production chain is the industry of milk transformation. Emissions associated to this actor are related to CO_2 emissions coming from milk processing, packaging and milk distribution. These stages represent, according to thesis data 0,17 kg $CO_{2\,eq}$· kg of milk^{-1}.

Milk industry efforts on increasing the efficiency of milk processing actions and lowering the impact associated to packaging are actions that at sector level can be boosted. Moreover, the selection of farms closed to milk processing industry and the promotion at local or regional distribution chains are factors that can reduce emissions impact associated to milk processing industry. Combined strategies can result on reducing emissions from 0,17 kg $CO_{2\,eq}$· kg of milk^{-1} to 0,14 kg $CO_{2\,eq}$· kg of milk^{-1}, which means a reduction of 18,44% emissions.

In both cases, fertilizers and milk industry, farmers can adopt an active role in the demand of environmental friendly products in terms of GHG emissions, through the request for the rest of milk sector chain of efforts to reduce the environmental impact of their actions. This positioning can make farmers responsible of lead a transformation of the production chain with environment impact in a highlight position, because not only can they act on their direct responsibility in the farm, but they can demand to the rest of stakeholders an active role in the reduction of environmental impact.

This role will allow farmers to present themselves as active stakeholders in the reduction of environmental impact with actions that directly concern them but also with the transformation of associated sectors in order to get a milk more respectfully with the environment.

The emissions associated to consumers role in the milk lifecycle, associated to retailing and consumer phase have not been considered with potential reduction impact, because it is a matter of consumer decisions as where they buy milk and how they transport and consume the milk, where the industry has no chance of interfere, so the impact in terms of GHG emissions for consumers is kept on 0,14 kg $CO_{2\,eq}\cdot$ kg of milk^{-1}.

In total, direct decisions taken from farmers in their farm, indirect decisions associated to pressure in other industries as fertilizers producers and the strengths of milk industry can mean reducing the impact on GHG emissions from 1,62 kg $CO_{2\,eq}\cdot$ kg of milk^{-1} to 1,36 kg $CO_{2\,eq}\cdot$ kg of milk^{-1}, which means a reduction of 16,18% emissions of milk sector at European level.

Apart from GHG impact of milk production, there are some other affection as resource consumption and land use for producing milk that consumers identify as important environmental impacts (Table 10). There is room to extend the milk impact analysis to these elements in order to propose alternatives to lessen environmental impact of milk industry.

4.3 Consumers preferences analysis

Consumers do not have an especial fidelity for their milk brand, with only 6% of people answering that “Not, never” would change their normal milk brand. Considering the answers “It could be” and “Probably” for the question “Would you change your normal milk brand for some other?” as indicator of potential change, 74,5% of people are on those categories, so there is an obvious group of people with potentiality for changing their normal milk brand selection. It shows that there is room for changing milk brand selection among consumers.

A deeper analysis of these data shows that the range of 36-45 years are more willing to change their decision (84,3%); having children is a factor that influences for having disposition to buy another milk brand (85,2%) and people with Secondary School training have the highest willingness to change their buy decision (86,4%). All these data show a potential target for people with disposition to change their brand milk. It is important to highlight that respondents with children are a group with high milk consumption, so the impact in terms of litres consumed by people with children will be more important than other groups.

The main factors to decide the milk brand decision are Price (62,0%), Quality (52,0%) and the Origin (45,5%) if it is produced in the country. Only 11,5% of times, interviewers selected Environmental Labels as a factor to choose milk brand selection. These data are in line to the answers for question of "What factors would you make to change your mind about milk brand?", with Price (56,5%), Quality (50,0%) and Origin, Produced in my Country (49,0%) as the three main factors. In that case, the existence of Environmental Labels was selected 24% of times.

The factors analysed in the present study to reduce milk environmental impact that can be highlighted for boosting a change on milk brand are the origin, as it was analysed as a potential factor to reduce GHG emissions. Nevertheless, the actions adopted to reduce environmental impact can be used indirectly to increase milk quality consumers' perception, so quality and mainly origin are the main criteria to be highlighted by producers in order to promote milk brand changes in the buyers. Environmental labels showing the efforts of milk industry in reducing the impact is one factor that can be considered to promote in order to make consumers select another milk brand, but not in the first position.

Regarding to the environmental factor, 36,0% of people would change their milk brand because this factor, but in the following interview section, 43,5% of interviewers answered that would pay an extra cost because the environmental factor. This increase shows that after receiving signals of the milk production impact, more people are willing to pay an extra cost if the brand milk reduces the environmental impact. It means that the more information the consumer receives about environmental impact, the more changes in milk brand for that reason are, so this information campaigns about the impact and the efforts to reduce the environmental impact are needed. According to the survey, these campaigns would be more successful if the information appears in a label or in a description in the packaging.

Considering the factors that can make consumers change their decision and the increase of importance of environmental issues once consumers receive more information about milk production impact, there is one aspect that can be boosted by milk industry. Increasing the information about environmental can make consumers more worried about it and so can increase the importance of this factor in the decision process of milk brand.

It is important to emphasize that 49,5% of people would pay an extra cost of 7% for a milk brand that offers the consumer what he/she demands as factor to pay more. In the second position of those factors is the Origin, produced in my region, so the factor of Origin is, again, a feature to highlight by milk producers.

All these elements suggest that there are important groups of people with disposition to change their milk brand if the new brand offer them price, quality and an origin near them. Moreover, the more information a consumer receives about environmental impact, the more important this factor is. Considering that almost half of participants in the interview would pay an extra cost of 7% for a milk offering them what they demand, there is room to boost milk industry to consider the adoption of measures to offer consumers what they demand, and to increase the information about environmental impact of milk production.

It is also important to relate the environmental impact reduction to quality and origin close to consumers, because these latter factors are important in the decision process to change the milk brand. In this regard, it is important to project correct information about the environmental impact in order to change the consumers' perception about where environmental impact in milk production are (Table 9).

There is room to analyse in detail the information that consumers should receive to change their brand selection and the way to transform efforts in environmental reduction in factors that effectively make consumers change their mind.

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Appendices

Table of content

Appendix 1. English questionnaire about consumer preferences.

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If you want to answer the survey in English, read below the following two paragraphs

Si quieres completar el cuestionario en español, pincha aquí: https://docs.google.com/forms/d/e/1FAIpQLSdNs2BfQpxfQ72qZxsLPZw5Y_Y0bg_tgebTAZ3uEKb6s38DZA/viewform

Jos haluat täyttää kyselyn suomeksi, klikkaa tästä: https://docs.google.com/forms/d/e/1FAIpQLSc6K_F9YSXyLS2PgdJnRwUyzVpfbdvs4U5fZxWlFslHTa47ow/viewform

This survey aims to analyse milk consumtion habits, environmental awareness and chances to modify consumption habits among consumers, trying to evaluate environmental reduction potential in the milk sector of Finland and Spain

The research will be used to write the final thesis of the Master "Natural Resource Management" that I am doing in Novia University, Finland

I thank you for the time spent to answer the survey (it won't take you more than 5 minutes) and the effort to forward it to your contacts, because the more surveys the better fot the research

Last but not least, if you want to receive information about final research conclussions, don't forget to complete your e-mail address in the last section of the survey

SIGUIENTE

Página 1 de 6

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*Obligatorio

Personal information

Where do you live? *

- [ ] Finland
- [ ] Spain
- [ ] Otro: ____________

Inhabitants of your city: *

- [ ] Less than 100
- [ ] 101 - 500
- [ ] 501 - 1.000
- [ ] 1.001 - 5.000
- [ ] 5.001 - 20.000
- [ ] 20.001 - 50.000
- [ ] 50.001 - 100.000
- [ ] More than 100.001

Gender *

- [ ] Male
- [ ] Female

Age *

Tu respuesta

Educational level *

- [ ] No schooling complete
- [ ] Primary school
- [ ] Secondary school
- [ ] Technical training
- [ ] Bachelor's degree
- [ ] Master's degree
- [ ] Doctorate

Employment *

- [ ] Student
- [ ] Unemployed
- [ ] Temporal job
- [ ] Fixed job
- [ ] Self-employed
- [ ] Retired

Educational level required for the current employment (or the last one) *

- [ ] I have never worked
- [ ] No schooling required
- [ ] Primary education
- [ ] Secondary education
- [ ] Technical training
- [ ] Bachelor's degree
- [ ] Master's degree
- [ ] Doctorate

Do you have children? *

- [ ] No
- [ ] Yes

If yes… how many of them are Living at home?

	0	1	2	3	4 or more
Under 18 years old	○	○	○	○	○
Over 18 years old	○	○	○	○	○

ATRÁS SIGUIENTE

Página 2 de 6

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*Obligatorio

Milk consumption habits

How often do you / your family consume milk? *

- [ ] Every day
- [ ] 4-6 days per week
- [ ] 1-3 days per week
- [ ] Never or rarely

How much milk do you and your family consume per week? (Take into account that 1 glass is aproximately 200 ml)

	0	0,1 - 0,5 l	0,6 - 1 l	1,1 - 1,5 l	1,6 - 2 l	2,1 - 3 l	3,1 - 4 l	More than 4,1 l
Only you	○	○	○	○	○	○	○	○
All your family	○	○	○	○	○	○	○	○

Indicate type and percentage of milk in your purchase bucket: *

	0%	1%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Whole milk	○	○	○	○	○	○
Semi-skimmed milk	○	○	○	○	○	○
Skimmed milk	○	○	○	○	○	○
Lactose free	○	○	○	○	○	○
Vitamin added or enriched milk	○	○	○	○	○	○

Do you always buy the same brand? *

- ☐ Yes, 90%-100% of times
- ☐ Almost, 50%-89% of times
- ☐ I try to do it, but not neccesarily, 25%-49& of times
- ☐ No, I don't pay attention to ti, 0% - 24% of times

Reasons to choose the brand

Select up to 3 options, 1 (the main reason), 2 (the second reason) and 3 (the third reason). Select the column "Error" if you selected a wrong option

	1	2	3	Error	Error
Price	○	○	○	○	○
Origin. Produced in my country	○	○	○	○	○
Origin. Produced closed to my living area	○	○	○	○	○
Quality	○	○	○	○	○
Flavour	○	○	○	○	○
Environmental labels	○	○	○	○	○
Container design	○	○	○	○	○
Media advertisement	○	○	○	○	○
Brand confidence	○	○	○	○	○
Others	○	○	○	○	○

If you selected "others" in the last question, list them

Tu respuesta

ATRÁS SIGUIENTE Página 3 de 6

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*Obligatorio

Milk sector environmental impact perception

What impact do you think milk production has for environment? *

- [ ] Very low impact
- [ ] Low impact
- [ ] Medium impact
- [ ] High impact
- [ ] Very high impact

In what phase of milk production you think are the biggest impacts to environment *

Order the sequence from 1 (the main impact) to 7 (the lowest impact)

	1	2	3	4	5	6	7
Animal feed production	○	○	○	○	○	○	○
Farm	○	○	○	○	○	○	○
Transport to diary	○	○	○	○	○	○	○
Dairy treatment	○	○	○	○	○	○	○
Transport to shops	○	○	○	○	○	○	○
Maintenance of milk in shops	○	○	○	○	○	○	○
Consumption by final consumers	○	○	○	○	○	○	○

What type of negative impacts do you associate more to milk production?

Select up to 3 options, 1 (the main impact), 2 (the second impact) and 3 (the third impact). Select the column "Error" if you selected a wrong option

	1	2	3	Error	Error
Resource consumption	○	○	○	○	○
Land use	○	○	○	○	○
Climate change	○	○	○	○	○
Ozone layer depletion	○	○	○	○	○
Human toxicity	○	○	○	○	○
Toxicity for environment	○	○	○	○	○
Photo-oxidant formation	○	○	○	○	○
Acidification	○	○	○	○	○
Eutrophication	○	○	○	○	○
Others	○	○	○	○	○

If you selected "others" in the last question, list them

Tu respuesta

Assign values to the sectors positively affected by milk production

Order the sequence from 1 (the more possitive affected sector) to 6 (the lowest possitive affected sector)

	1	2	3	4	5	6
National economy	○	○	○	○	○	○
Local economy	○	○	○	○	○	○
National environment	○	○	○	○	○	○
Local environment	○	○	○	○	○	○
National employment	○	○	○	○	○	○
Local employment	○	○	○	○	○	○
Others	○	○	○	○	○	○

If you selected "others" in the last question, list them

Tu respuesta

ATRÁS SIGUIENTE Página 4 de 6

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*Obligatorio

Factors to change purchasing decision

Would you change your normal brand for some other? *

- [ ] Not, never
- [ ] It could be
- [ ] Probably
- [ ] I don't have any preference

What factors would you make to change your mind about milk brand?

Select up to 3 options, 1 (the main factor), 2 (the second factor) and 3 (the third factor). Select the column "Error" if you selected a wrong option

	1	2	3	Error	Error
Lower price	○	○	○	○	○
Origin. Produced in my country	○	○	○	○	○
Origin. Produced in my region	○	○	○	○	○
Quality	○	○	○	○	○
Environmental labels	○	○	○	○	○
Less energy consumption in the production	○	○	○	○	○
Container design	○	○	○	○	○
Media advertisement	○	○	○	○	○
Brand confidence	○	○	○	○	○
Social factors (Social Corporation Responsibility...)	○	○	○	○	○
Others	○	○	○	○	○

If you selected "others" in the last question, list them

Tu respuesta

Would you pay an extra cost for some of these reasons?

Select up to 3 options, 1 (the main reason to pay an extra cost), 2 (the second reason) and 3 (the third reason). Select the column "Error" if you selected a wrong option

	1	2	3	Error	Error
Origin. Produced in my country	○	○	○	○	○
Origin. Produced in my region	○	○	○	○	○
Quality	○	○	○	○	○
Flavour	○	○	○	○	○
Environmental labels	○	○	○	○	○
Less energy consumption in the production	○	○	○	○	○
Container design	○	○	○	○	○
Media advertisement	○	○	○	○	○
Brand confidence	○	○	○	○	○
Social factors (Social Corporation Responsibility...)	○	○	○	○	○
Others	○	○	○	○	○

If you selected "others" in the last question, list them

Tu respuesta

According to your previous selection, how much would you extra pay? *

Select extra cost for the factors you selected in the question

	0%	1% - 3%	4% - 6%	7% - 10%	11% - 15%	16% - 20%	21% - 30%	31% - 40 %	41% - 50%
Answer 1 of the "extra cost" question	○	○	○	○	○	○	○	○	○
Answer 2 of the "extra cost" question	○	○	○	○	○	○	○	○	○
Answer 3 of the "extra cost" question	○	○	○	○	○	○	○	○	○

Would you choose a milk brand instead the tradicional one if…

Select 1 to 5: 1 (never), 2 (seldom), 3 (sometimes), 4 (often), 5 (always)):

	1	2	3	4	5
The brand makes efforts to reduce energy consumption	○	○	○	○	○
The brand makes efforts to reduce its environmental impact	○	○	○	○	○
The brand makes efforts to improve local employment	○	○	○	○	○
The brand makes efforts to improve local development	○	○	○	○	○
Other	○	○	○	○	○

If you selected "others" in the last question, list them

Tu respuesta

How would you like to be informed about these efforts? *

- [ ] With a label in the packaging
- [ ] With an informative campaign (TV, media,…)
- [ ] With a detailed information in its website
- [ ] With a description in the packaging
- [ ] With promotional campaigns
- [ ] Otro: ____

ATRÁS SIGUIENTE

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More information

If you want to be updated about the advances and conclussions of the research, write down your e-mail

Thank you very much

E-mail

Tu respuesta

ATRÁS ENVIAR Página 6 de 6

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Appendix 2. Tables with questionnaire results

Section 2. “Personal Information”

	Where do you live?	Inhabitants of your city:	Gender	Age	Educational level	Employment	Educational level required for the current employment (or the last one)	Do you have children?	If yes… how many of them are Living at home? [Under 18 years old]	If yes… how ma are Living at hor 18 years
Answer	Spain	Less than 100	Male	<25	No schooling complete	Student	I have never worked	Yes	0	
Number	141	3	98	33	0	38	3	88	19	
Percentage	70,50%	1,50%	49,00%	16,50%	0,00%	19,00%	1,50%	44,00%	21,59%	
Answer	Finland	101-500	Female	25-35	Primary school	Unemployed	No schooling required	No	1	
Number	51	3	102	71	0	11	14	112	27	
Percentage	25,50%	1,50%	51,00%	35,50%	0,00%	5,50%	7,00%	56,00%	30,68%	
Answer	Others	501 - 1.000		36-45	Secondary school	Temporal job	Primary education		2	
Number	8	7		60	22	31	6		37	
Percentage	4,00%	3,50%		30,00%	11,00%	15,50%	3,00%		42,05%	
Answer		1.001 - 5.000		46-55	Technical training	Fixed job	Secondary education		3	
Number		7		24	25	94	27		4	
Percentage		3,50%		12,00%	12,50%	47,00%	13,50%		4,55%	
Answer		5.000 - 20.000		56-65	Bachelor's degree	Self-employed	Technical training		4 or more	
Number		29		9	107	23	27		1	
Percentage		14,50%		4,50%	53,50%	11,50%	13,50%		1,14%	
Answer		20.001 - 50.000		>65	Master's degree	Retired	Bachelor's degree			
Number		25		3	32	3	102			
Percentage		12,50%		1,50%	16,00%	1,50%	51,00%			
Answer		50.001 - 100.000			Doctorate		Master's degree			
Number		75			14		14			
Percentage		37,50%			7,00%		7,00%			
Answer		More than 100.001					Doctorate			
Number		51					7			
Percentage		25,50%					3,50%			

Sections 3. “Milk Consumption Habits”

	How often do you / your family consume milk?	How much milk do you and your family consume per week? (Take into account that 1 glass is aproximately 200 ml) [Only you]	How much milk do you and your family consume per week? (Take into account that 1 glass is aproximately 200 ml) [All your family]	Indicate type and percentage of milk in your purchase bucket: [Whole milk]	Indicate type and percentage of milk in your purchase bucket: [Semi-skimmed milk]	Indicate type and percentage of milk in your purchase bucket: [Skimmed milk]	Indicate type and percentage of milk in your purchase bucket: [Lactose free]	Indicate type and percentage of milk in your purchase bucket: [Vitamin added or enriched milk]
Answer	Every day	0	1	0%	0%	0%	0%	0%
Number	164	14	8	122	88	118	150	171
Percentage	82,00%	7,00%	4,00%	61,00%	44,00%	59,00%	75,00%	85,50%
Answer	4-6 days per week	0,1-0,5 l	0,1-0,5 l	1% - 20%	1% - 20%	1% - 20%	1% - 20%	1% - 20%
Number	16	53	25	33	29	29	17	10
Percentage	8,00%	26,50%	12,50%	16,50%	14,50%	14,50%	8,50%	5,00%
Answer	1-3 days per week	0,6 - 1 l	0,6 - 1 l	21% - 40%	21% - 40%	21% - 40%	21% - 40%	21% - 40%
Number	5	37	25	8	16	17	11	2
Percentage	2,50%	18,50%	12,50%	4,00%	8,00%	8,50%	5,50%	1,00%
Answer	Never or rarely	1,1 - 1,5 l	1,1 - 1,5 l	41% - 60%	41% - 60%	41% - 60%	41% - 60%	41% - 60%
Number	15	32	18	8	10	6	4	0
Percentage	7,50%	16,00%	9,00%	4,00%	5,00%	3,00%	2,00%	0,00%
Answer		1,6 - 2 l	1,6 - 2 l	61% - 80%	61% - 80%	61% - 80%	61% - 80%	61% - 80%
Number		25	23	8	15	7	4	7
Percentage		12,50%	11,50%	4,00%	7,50%	3,50%	2,00%	3,50%
Answer		2,1 - 3 l	2,1 - 3 l	81% - 100%	81% - 100%	81% - 100%	81% - 100%	81% - 100%
Number		21	20	21	42	23	14	10
Percentage		10,50%	10,00%	10,50%	21,00%	11,50%	7,00%	5,00%
Answer		3,1 - 4 l	3,1 - 4 l					
Number		13	26					
Percentage		6,50%	13,00%					
Answer		More than 4,1 l	More than 4,1 l					
Number		5	55					
Percentage		2,50%	27,50%					

	Do you always buy the same brand?	Reasons to choose the brand [Price]	Reasons to choose the brand [Origin. Produced in my country]	Reasons to choose the brand [Origin. Produced closed to my living area]	Reasons to choose the brand [Quality]	Reasons to choose the brand [Flavour]	Reasons to choose the brand [Environmental labels]	Reasons to choose the brand [Container design]	Reasons to choose the brand [Media advertisement]	Reasons to choose the brand [Brand confidence]	Reasons to choose the bran [Others]
Answer	Yes, 90%-100% of times	1	1	1	1	1	1	1	1	1	
Number	99	58	27	19	41	24	4	0	0	14	
Percentage	49,50%	46,77%	29,67%	40,43%	39,42%	29,63%	17,39%	0,00%	0,00%	21,88%	44,44
Answer	Almost, 50%-89% of times	2	2	2	2	2	2	2	2	2	
Number	64	31	44	17	42	31	6	4	1	12	
Percentage	32,00%	25,00%	48,35%	36,17%	40,38%	38,27%	26,09%	50,00%	33,33%	18,75%	5,56
Answer	I try to do it, but neccesarily, 25%49% of times	3	3	3	3	3	3	3	3	3	
Number	17	35	20	11	21	26	13	4	2	38	
Percentage	8,50%	28,23%	21,98%	23,40%	20,19%	32,10%	56,52%	50,00%	66,67%	59,38%	50,00
Answer	No, I don't pay attention to it, 0% - 24% of times										
Number	20										
Percentage	10,00%										

Section 4 “Milk Sector Environment Impact

	What impact do you think milk production has for environment?	In what phase of milk production you think are the biggest impacts to environment [Animal feed production]	In what phase of milk production you think are the biggest impacts to environment [Farm]	In what phase of milk production you think are the biggest impacts to environment [Transport to diary]	In what phase of milk production you think are the biggest impacts to environment [Dairy treatment]	In what phase of milk production you think are the biggest impacts to environment [Transport to shops]	In what phase of milk production you think are the biggest impacts to environment [Maintenance of milk in shops]	In what phase of milk production you think are the biggest impacts to environment [Consumption by final consumers]
Answer	Very low impact	1	1	1	1	1	1	1
Number	14	62	29	13	37	25	11	23
Percentage	7,00%	31,00%	14,50%	6,50%	18,50%	12,50%	5,50%	11,50%
Answer	Low impact	2	2	2	2	2	2	2
Number	37	46	29	35	26	38	13	13
Percentage	18,50%	23,00%	14,50%	17,50%	13,00%	19,00%	6,50%	6,50%
Answer	Medium impact	3	3	3	3	3	3	3
Number	85	9	36	50	42	37	16	10
Percentage	42,50%	4,50%	18,00%	25,00%	21,00%	18,50%	8,00%	5,00%
Answer	High impact	4	4	4	4	4	4	4
Number	54	23	13	45	38	36	22	23
Percentage	27,00%	11,50%	6,50%	22,50%	19,00%	18,00%	11,00%	11,50%
Answer	Very high impact	5	5	5	5	5	5	5
Number	10	12	26	33	36	34	36	23
Percentage	5,00%	6,00%	13,00%	16,50%	18,00%	17,00%	18,00%	11,50%
Answer		6	6	6	6	6	6	6
Number		16	39	20	11	23	66	25
Percentage		8,00%	19,50%	10,00%	5,50%	11,50%	33,00%	12,50%
Answer		7	7	7	7	7	7	7
Number		32	28	4	10	7	36	83
Percentage		16,00%	14,00%	2,00%	5,00%	3,50%	18,00%	41,50%

	What type of negative impacts do you associate more to milk production? [Resource consumption]	What type of negative impacts do you associate more to milk production? [Land use]	What type of negative impacts do you associate more to milk production? [Climate change]	What type of negative impacts do you associate more to milk production? [Ozone layer depletion]	What type of negative impacts do you associate more to milk production? [Human toxicity]	What type of negative impacts do you associate more to milk production? [Toxicity for environment]	What type of negative impacts do you associate more to milk production? [Photo-oxidant formation]	What type of negative impacts do you associate more to milk production? [Acidification]	What type of negative impacts do you associate more to milk production? [Eutrophication]	What type of negative impacts do you associate more to milk production? [Others]
Answer	1	1	1	1	1	1	1	1	1	11
Number	59	14	30	24	9	21	9	11	10	5
Percentage	46,09%	17,50%	32,61%	39,34%	27,27%	28,77%	39,13%	45,83%	26,32%	83,33%
Answer	2	2	2	2	2	2	2	2	2	12
Number	35	41	31	15	13	24	6	8	12	0
Percentage	27,34%	51,25%	33,70%	24,59%	39,39%	32,88%	26,09%	33,33%	31,58%	0,00%
Answer	3	3	3	3	3	3	3	3	3	3
Number	34	25	31	22	11	28	8	5	16	1
Percentage	26,56%	31,25%	33,70%	36,07%	33,33%	38,36%	34,78%	20,83%	42,11%	16,67%

	Assign values to the sectors positively affected by milk production [National economy]	Assign values to the sectors positively affected by milk production [Local economy]	Assign values to the sectors positively affected by milk production [National environment]	Assign values to the sectors positively affected by milk production [Local environment]	Assign values to the sectors positively affected by milk production [National employment]	Assign values to the sectors positively affected by milk production [Local employment]	Assign values to the sectors positively affected by milk production [Others]
Answer	1	1	1	1	1	1	1
Number	44	82	1	5	8	50	2
Percentage	22,92%	42,71%	0,52%	2,60%	4,17%	26,04%	1,04%
Answer	2	2	2	2	2	2	2
Number	32	56	7	13	27	56	0
Percentage	16,75%	29,32%	3,66%	6,81%	14,14%	29,32%	0,00%
Answer	3	3	3	3	3	3	3
Number	39	24	18	37	40	29	0
Percentage	20,86%	12,83%	9,63%	19,79%	21,39%	15,51%	0,00%
Answer	4	4	4	4	4	4	4
Number	37	11	23	21	52	17	0
Percentage	22,98%	6,83%	14,29%	13,04%	32,30%	10,56%	0,00%
Answer	5	5	5	5	5	5	5
Number	12	7	45	52	22	19	0
Percentage	7,64%	4,46%	28,66%	33,12%	14,01%	12,10%	0,00%
Answer	6	6	6	6	6	6	6
Number	15	9	63	31	22	13	2
Percentage	9,68%	5,81%	40,65%	20,00%	14,19%	8,39%	1,29%

Section 5 “Factors to Change Purchasing”

	Would you change your normal brand for some other?	What factors would you make to change your mind about milk brand? [Lower price]	What factors would you make to change your mind about milk brand? [Origin. Produced in my country]	What factors would you make to change your mind about milk brand? [Origin. Produced in my region]	What factors would you make to change your mind about milk brand? [Quality]	What factors would you make to change your mind about milk brand? [Environmental labels]	What factors would you make to change your mind about milk brand? [Less energy consumption in the production]	What factors would you make to change your mind about milk brand? [Container design]	What factors would you make to change your mind about milk brand? [Media advertisement]	What factors would you make to change your mind about milk brand? [Brand confidence]	What factors would you make to change your mind about milk brand? [Social factors (Social Corporation Responsibility...)]	What factors would you make to change your mind about milk brand? [Others]
Answer	Not, never	1	1	1	1	1	1	1	1	1	1	1
Number	12	53	13	26	61	14	3	0	1	4	15	7
Percentage	6,00%	53,00%	22,41%	26,53%	53,98%	29,17%	7,89%	0,00%	33,33%	12,90%	26,79%	63,64%
Answer	It could be	2	2	2	2	2	2	2	2	2	2	2
Number	104	21	27	37	36	11	23	1	1	13	15	2
Percentage	52,00%	21,00%	46,55%	37,76%	31,86%	22,92%	60,53%	11,11%	33,33%	41,94%	26,79%	18,18%
Answer	Probably	3	3	3	3	3	3	3	3	3	3	3
Number	45	26	18	35	16	23	12	8	1	14	26	2
Percentage	22,50%	26,00%	31,03%	35,71%	14,16%	47,92%	31,58%	88,89%	33,33%	45,16%	46,43%	18,18%
Answer	I don't have any preference											
Number	39											
Percentage	19,50%											

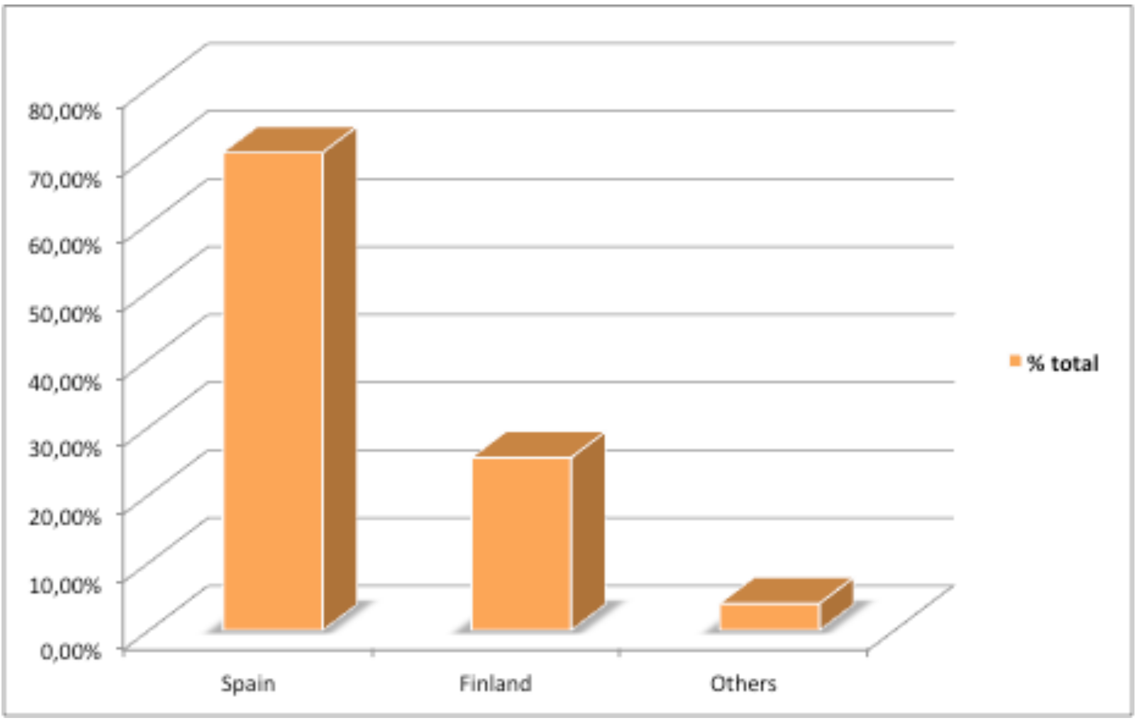
	Would you pay an extra cost for some of these reasons? [Origin. Produced in my country]	Would you pay an extra cost for some of these reasons? [Origin. Produced in my region]	Would you pay an extra cost for some of these reasons? [Quality]	Would you pay an extra cost for some of these reasons? [Flavour]	Would you pay an extra cost for some of these reasons? [Environmental labels]	Would you pay an extra cost for some of these reasons? [Less energy consumption in the production]	Would you pay an extra cost for some of these reasons? [Container design]	Would you pay an extra cost for some of these reasons? [Media advertisement]	Would you pay an extra cost for some of these reasons? [Brand confidence]	Would you pay an extra cost for some of these reasons? [Social factors (Social Corporation Responsibility...)]	Would you pay an extra cost for some of these reasons? [Others]
Answer	1	1	1	1	1	1	1	1	1	1	1
Number	20	51	67	22	14	4	0	0	0	15	3
Percentage	29,85%	43,59%	49,26%	30,14%	25,93%	8,16%	0,00%	0,00%	0,00%	27,78%	50,00%
Answer	2	2	2	2	2	2	2	2	2	2	2
Number	24	33	39	36	18	23	1	0	4	13	1
Percentage	35,82%	28,21%	28,68%	49,32%	33,33%	46,94%	25,00%	0,00%	22,22%	24,07%	16,67%
Answer	3	3	3	3	3	3	3	3	3	3	3
Number	23	33	30	15	22	22	3	1	14	26	2
Percentage	34,33%	28,21%	22,06%	20,55%	40,74%	44,90%	75,00%	100,00%	77,78%	48,15%	33,33%

	According to your previous selection, how much would you extra pay? [Answer 1 of the "extra cost" question]	According to your previous selection, how much would you extra pay? [Answer 2 of the "extra cost" question]	According to your previous selection, how much would you extra pay? [Answer 3 of the "extra cost" question]	Would you choose a milk brand instead the tradicional one if… [The brand makes efforts to reduce energy consumption]	Would you choose a milk brand instead the tradicional one if… [The brand makes efforts to reduce its environmental	Would you choose a milk brand instead the tradicional one if… [The brand makes efforts to improve local employment]	Would you choose a milk brand instead the tradicional one if… [The brand makes efforts to improve local development]	Would you choose a milk brand instead the tradicional one if… [Other]
Answer	0%	100%	200%	1	1	1	1	1
Number	10	12	22	14	13	19	12	13
Percentage	5,00%	6,00%	11,00%	7,45%	6,81%	10,16%	6,45%	50,00%
Answer	1%-3%	1%-3%	1%-3%	2	2	2	2	2
Number	44	65	66	44	37	18	22	2
Percentage	22,00%	32,50%	33,00%	23,40%	19,37%	9,63%	11,83%	7,69%
Answer	4%-6%	4%-6%	4%-6%	3	3	3	3	3
Number	47	44	36	67	65	40	39	0
Percentage	23,50%	22,00%	18,00%	35,64%	34,03%	21,39%	20,97%	0,00%
Answer	7%-10%	7%-10%	7%-10%	4	4	4	4	4
Number	41	37	31	38	47	66	69	1
Percentage	20,50%	18,50%	15,50%	20,21%	24,61%	35,29%	37,10%	3,85%
Answer	11%-15%	11%-15%	11%-15%	5	5	5	5	5
Number	23	16	17	25	29	44	44	10
Percentage	11,50%	8,00%	8,50%	13,30%	15,18%	23,53%	23,66%	38,46%
Answer	16%-20%	16%-20%	16%-20%					
Number	17	12	14					
Percentage	8,50%	6,00%	7,00%					
Answer	21%-30%	21%-30%	21%-30%					
Number	9	5	9					
Percentage	4,50%	2,50%	4,50%					
Answer	31%-40%	31%-40%	31%-40%					
Number	2	5	1					
Percentage	1,00%	2,50%	0,50%					
Answer	41%-50%	41%-50%	41%-50%					
Number	5	3	3					
Percentage	2,50%	1,50%	1,50%					
Answer	More than 51%	More than 51%	More than 51%					
Number	2	1	1					
Percentage	1,00%	0,50%	0,50%					

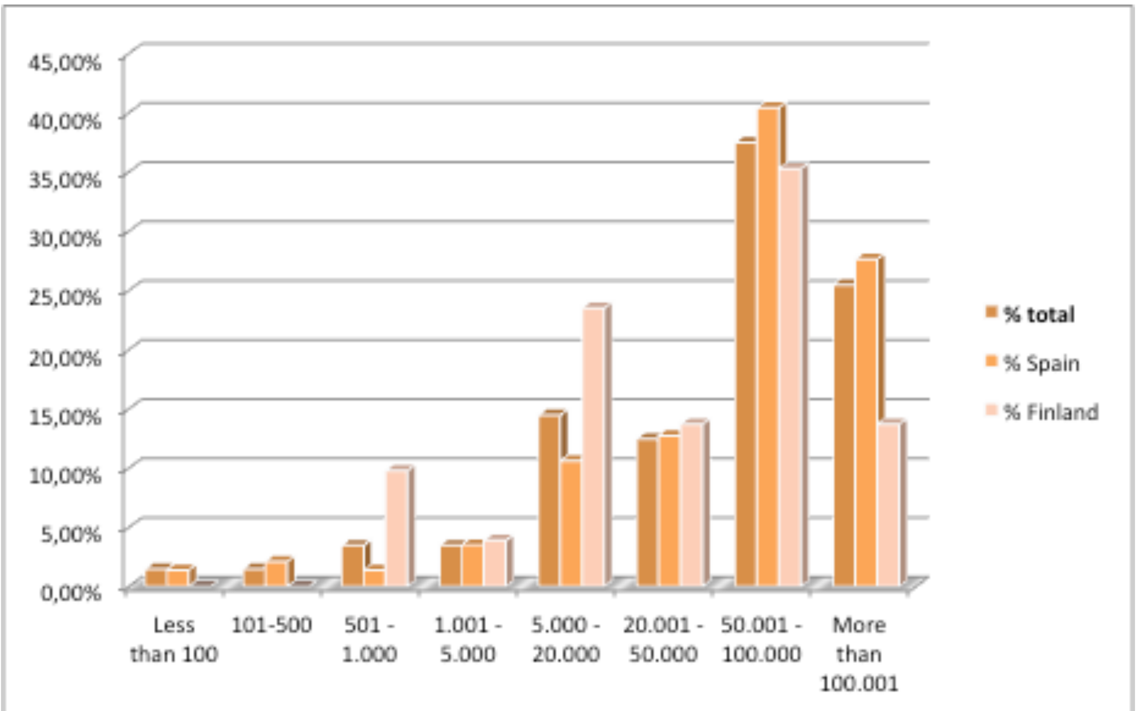
	With a label in the packaging	With an informative campaign (TV, media,…)	With a detailed information in its website	With a description in the packaging	With promotional campaigns
Answer	1	1	1	1	1
Number	112	58	41	98	34
Percentage	100,00%	100,00%	100,00%	100,00%	100,00%

Appendix 3. Questionnaire results in charts

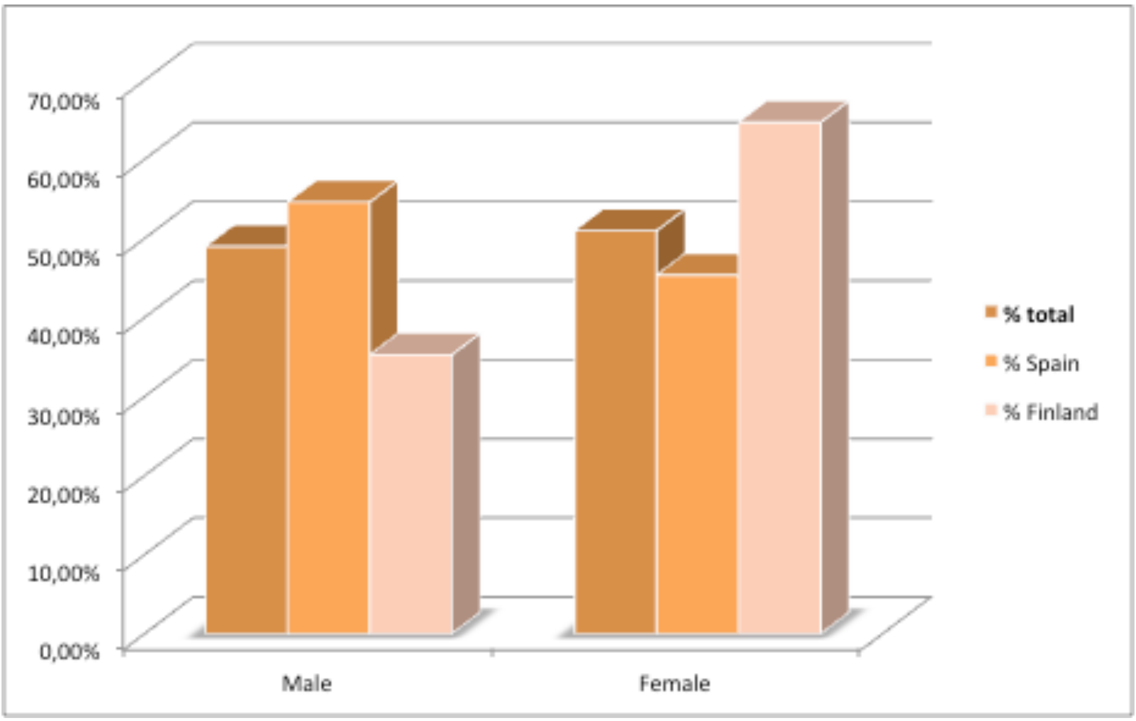
Where do you live?



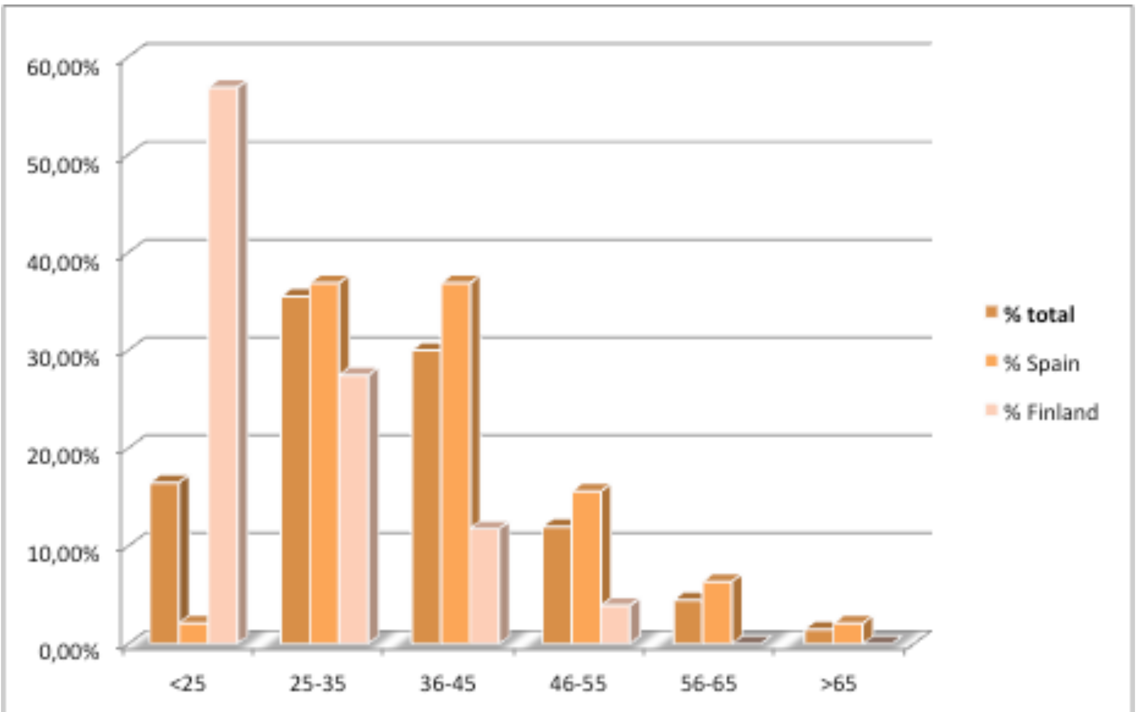
Inhabitants of your city



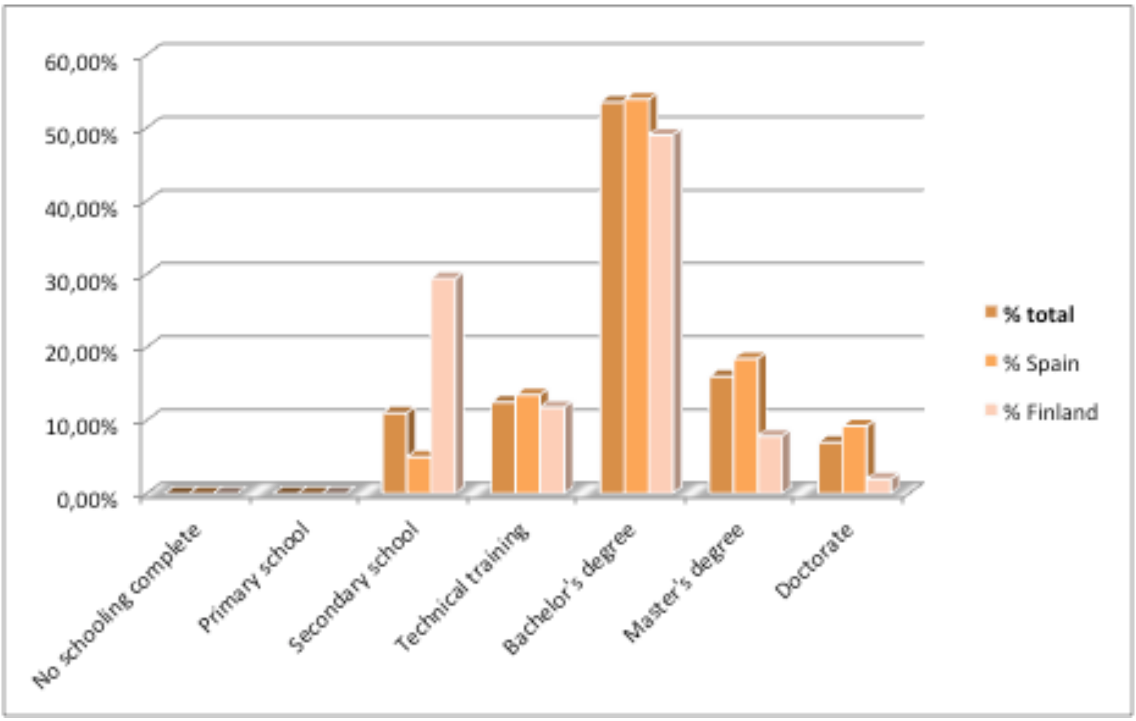
Gender


70,00%
60,00%
50,00%
40,00%
30,00%
20,00%
10,00%
0,00%
Male
Female
% total
% Spain
% Finland

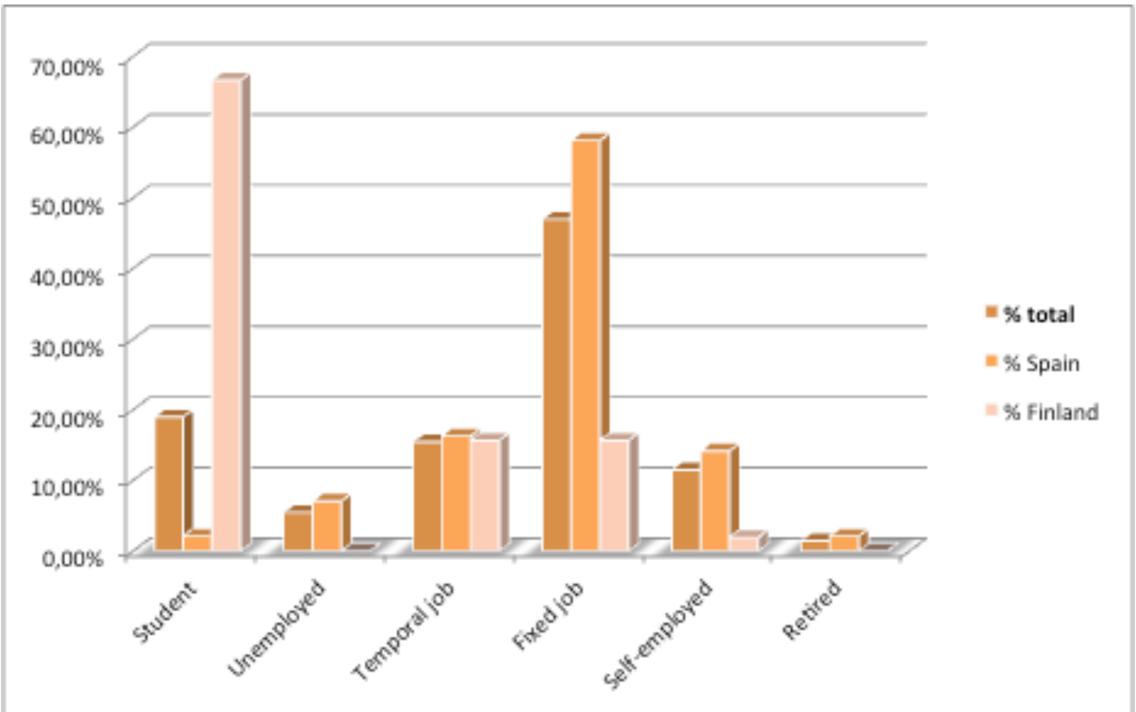
Age


60,00%
50,00%
40,00%
30,00%
20,00%
10,00%
0,00%
<25
25-35
36-45
46-55
56-65
>65
% total
% Spain
% Finland

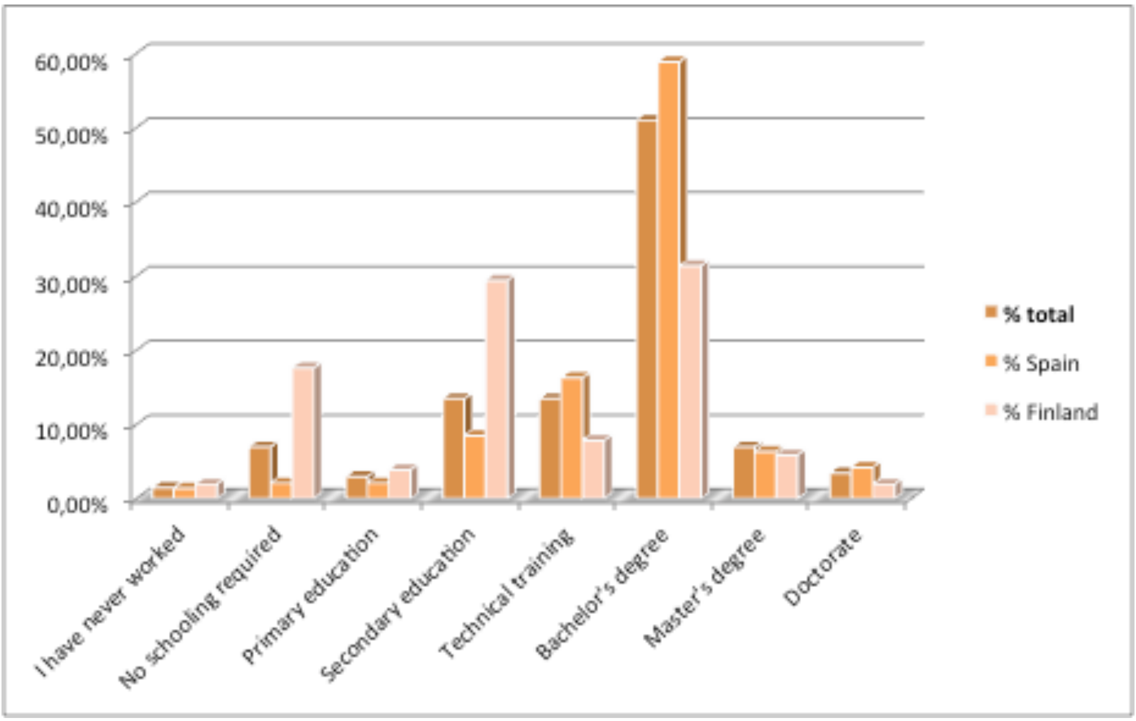
Educational level



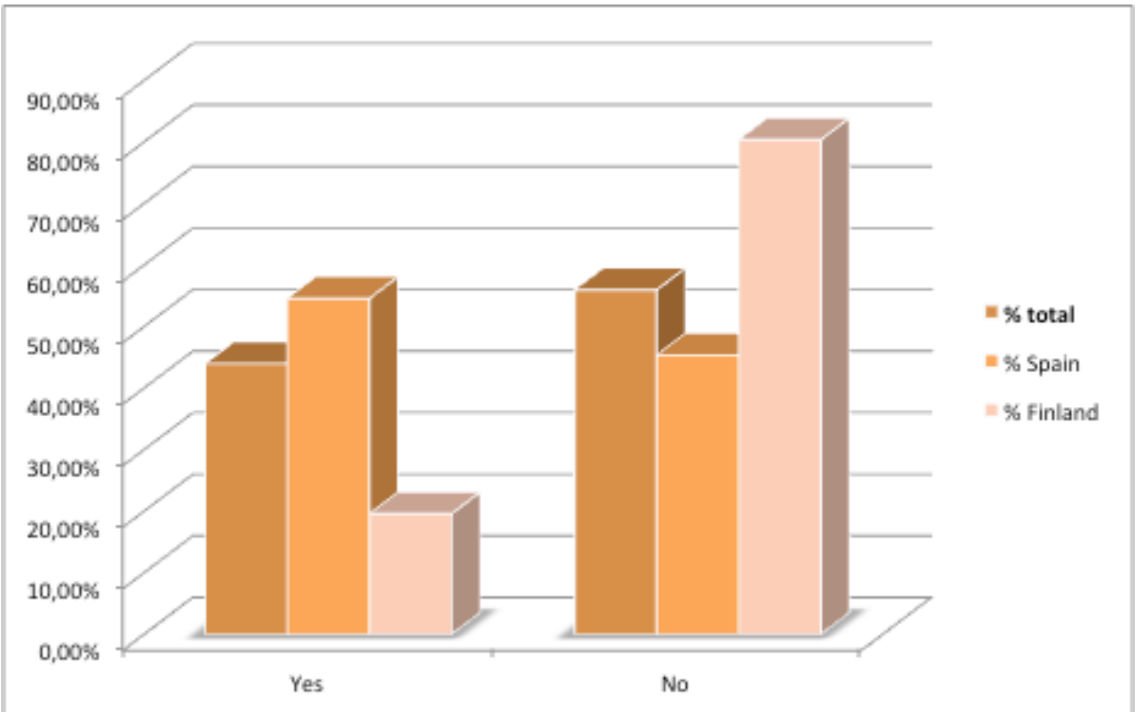
Employment



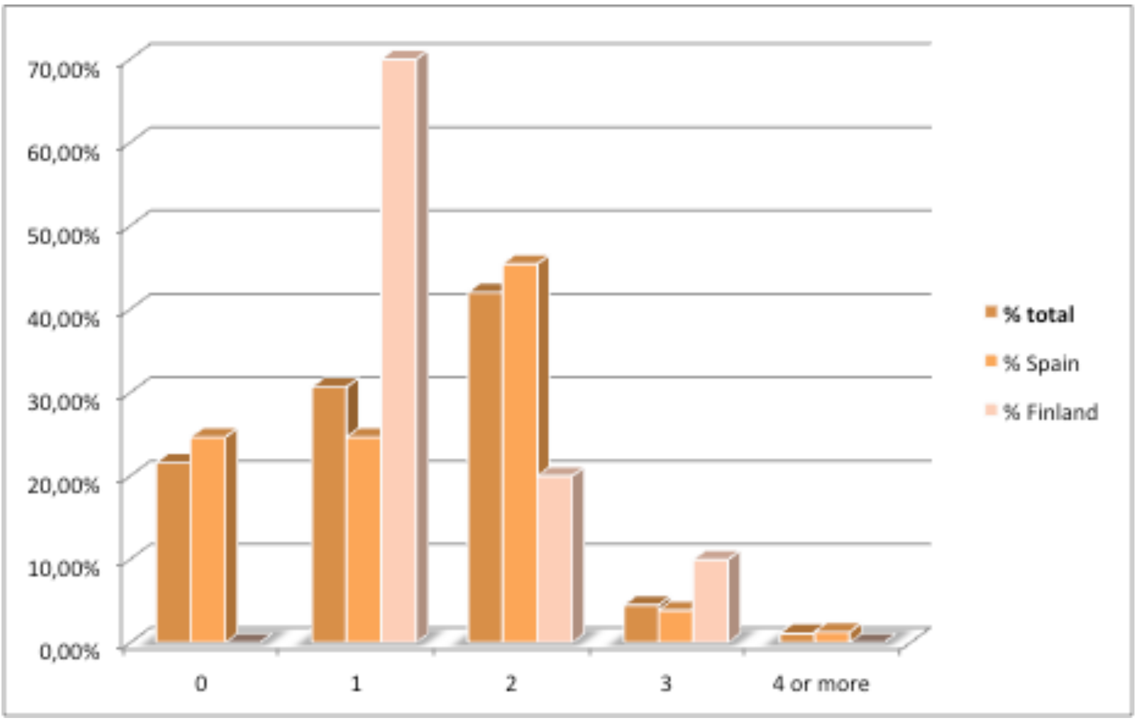
Educational level required for the current employment (or the last one)



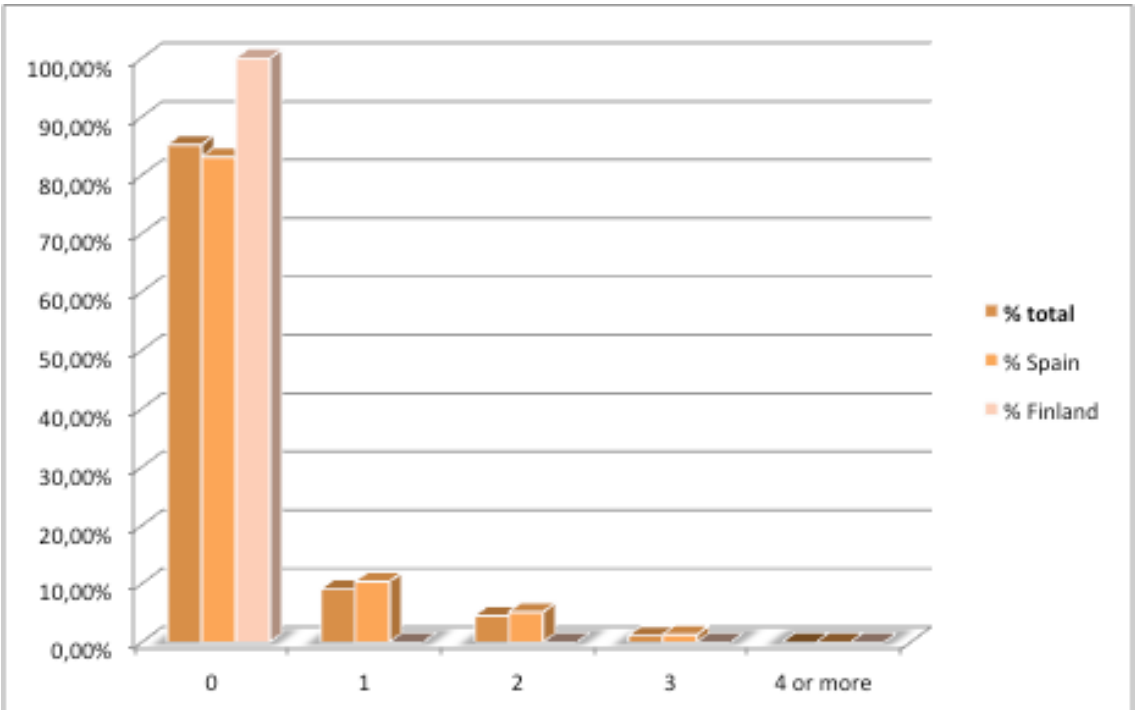
Do you have children?



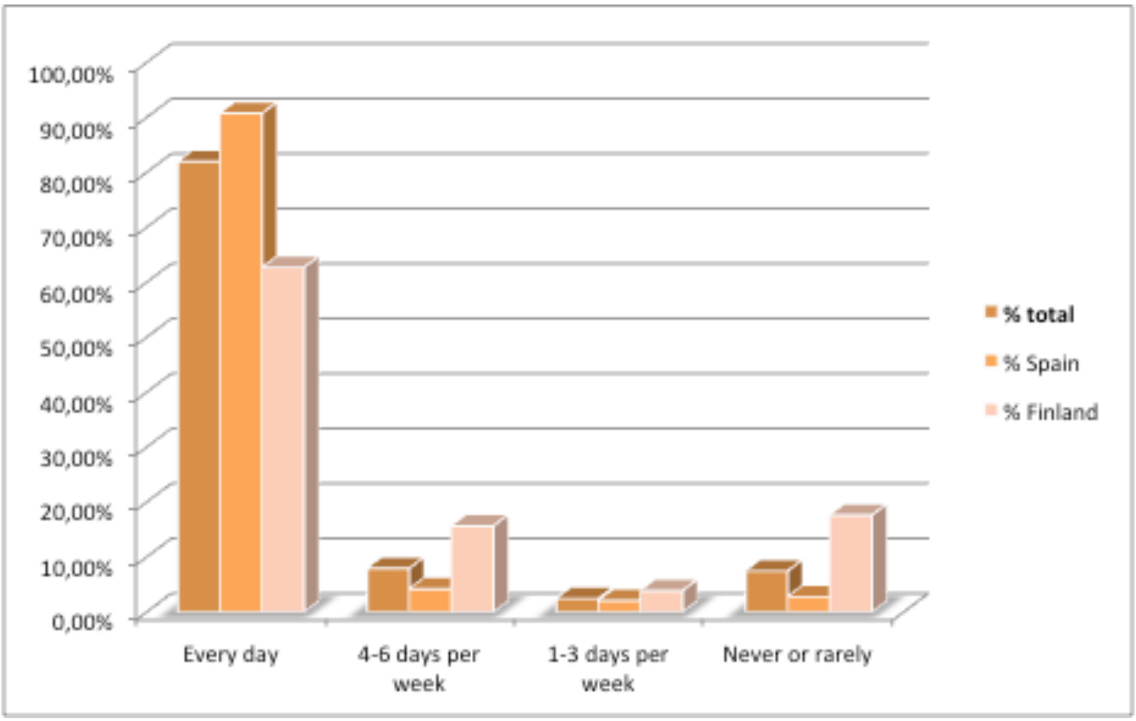
If yes… how many of them are Living at home? [Under 18 years old]



If yes… how many of them are Living at home? [Over 18 years old]

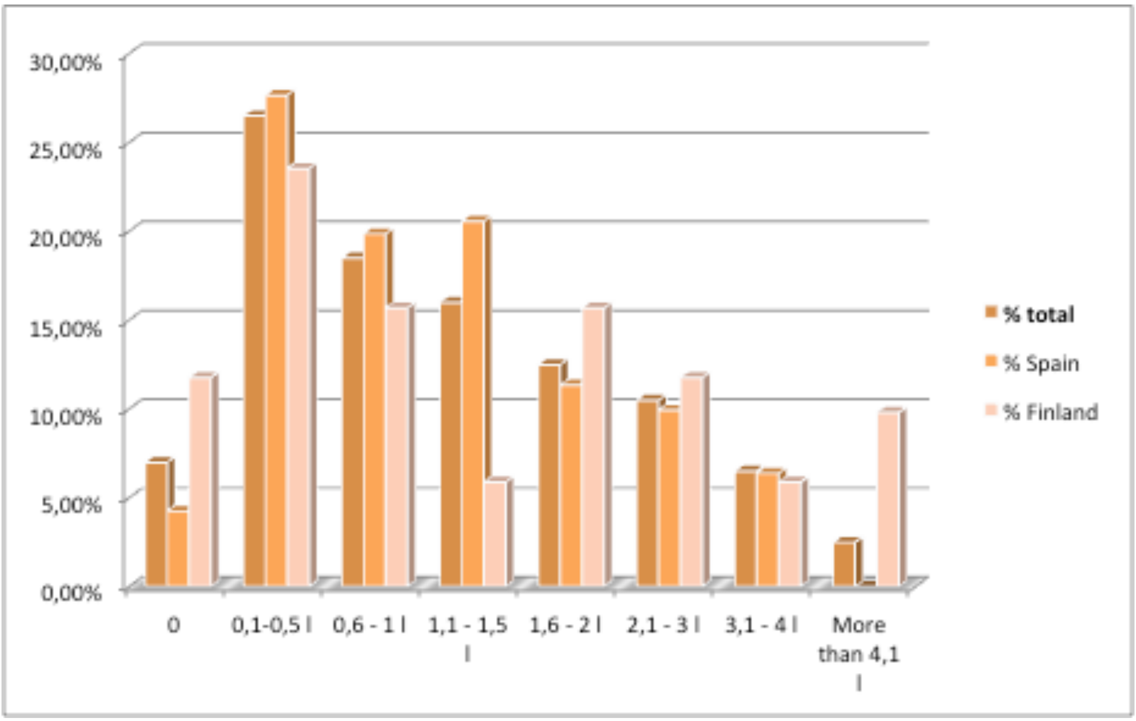


How often do you / your family consume milk?

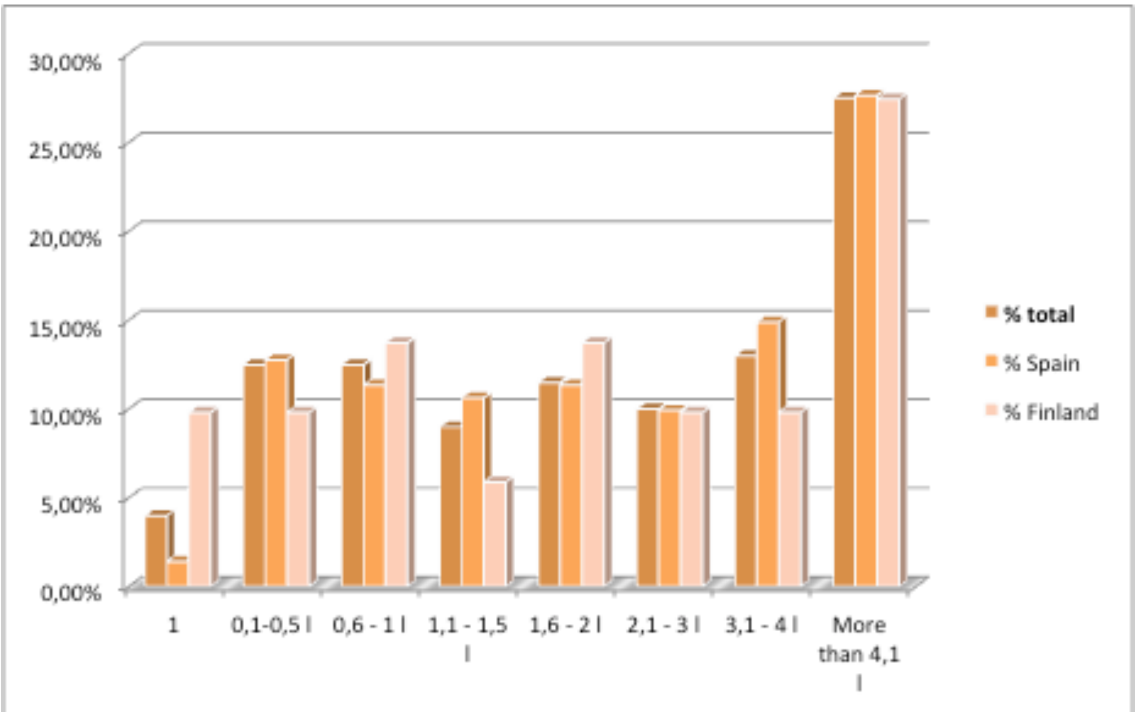

100,00%
90,00%
80,00%
70,00%
60,00%
50,00%
40,00%
30,00%
20,00%
10,00%
0,00%
Every day
4-6 days per week
1-3 days per week
Never or rarely
% total
% Spain
% Finland

How much milk do you and your family consume per week? (litres)

Only you

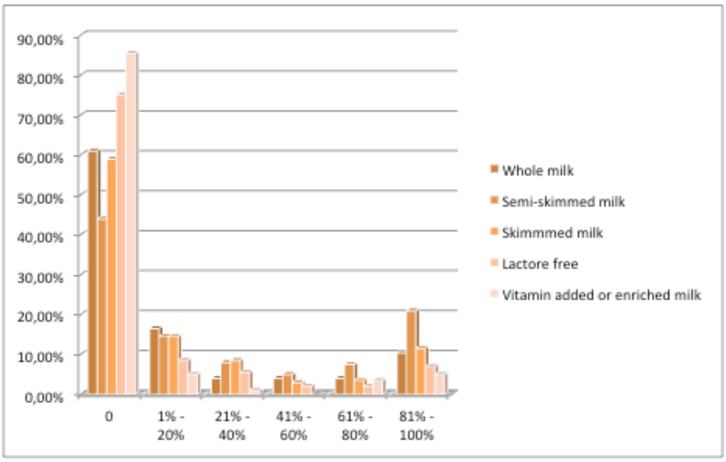


All your family

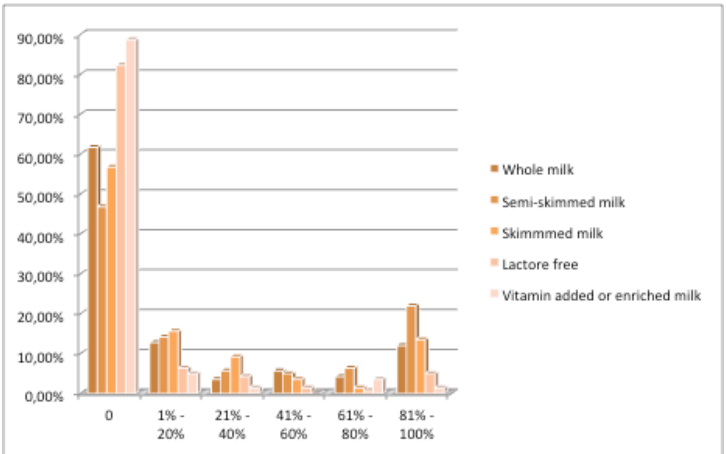


Indicate type and percentage of milk in your purchase bucket:

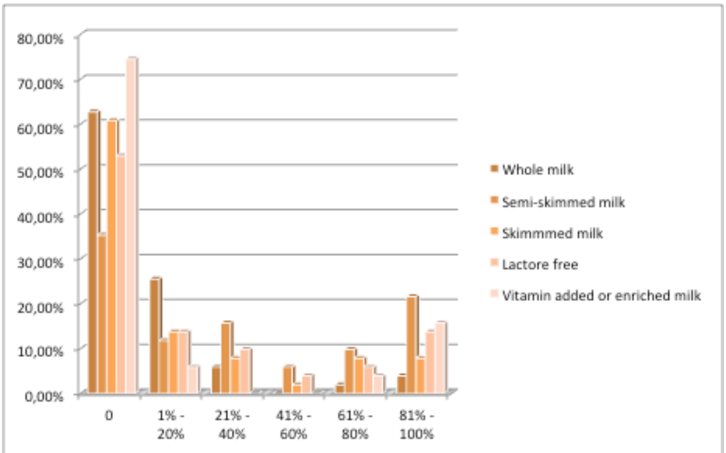
% total



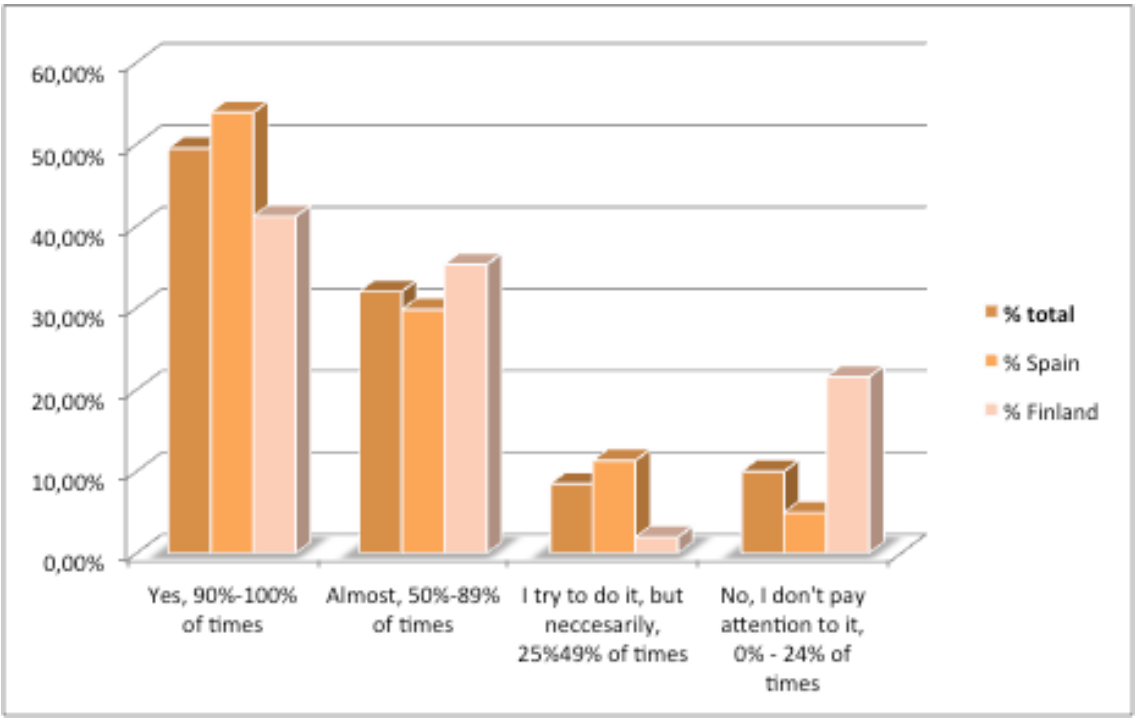
% Spain



% Finland

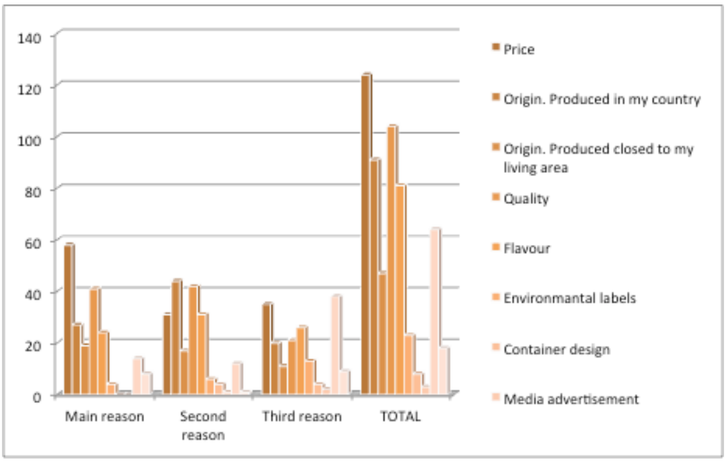


Do you always buy the same brand?

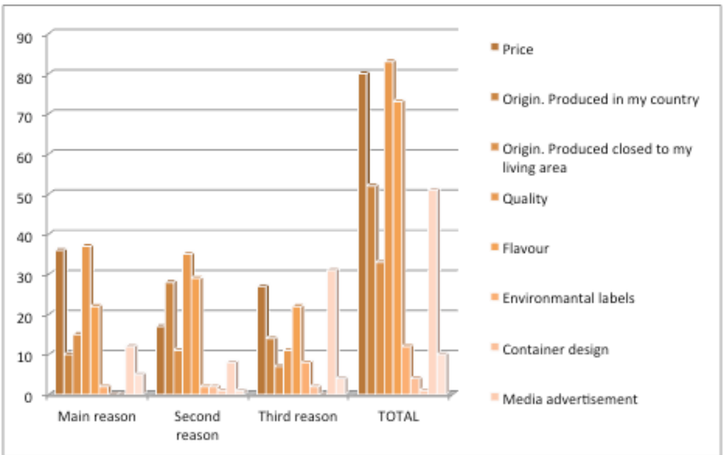

60,00%
50,00%
40,00%
30,00%
20,00%
10,00%
0,00%
Yes, 90%-100% of times
Almost, 50%-89% of times
I try to do it, but neccesarily, 25%49% of times
No, I don't pay attention to it, 0% - 24% of times
% total
% Spain
% Finland

Reasons to choose the brand (Select up to 3 options, 1 (the main reason), 2 (the second reason) and 3 (the third reason)

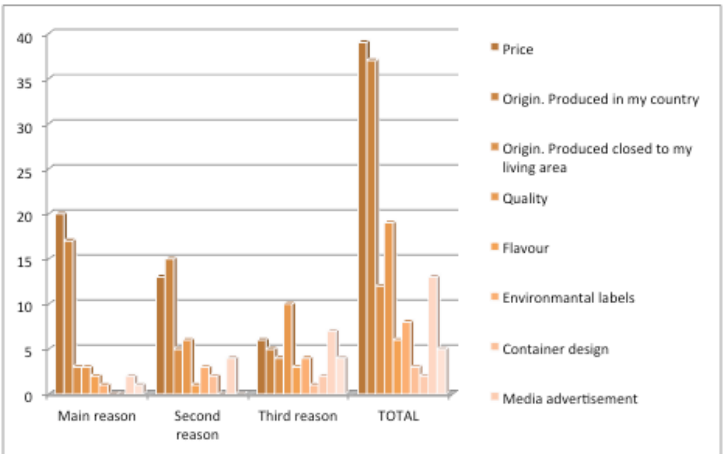
TOTAL ANSWERS



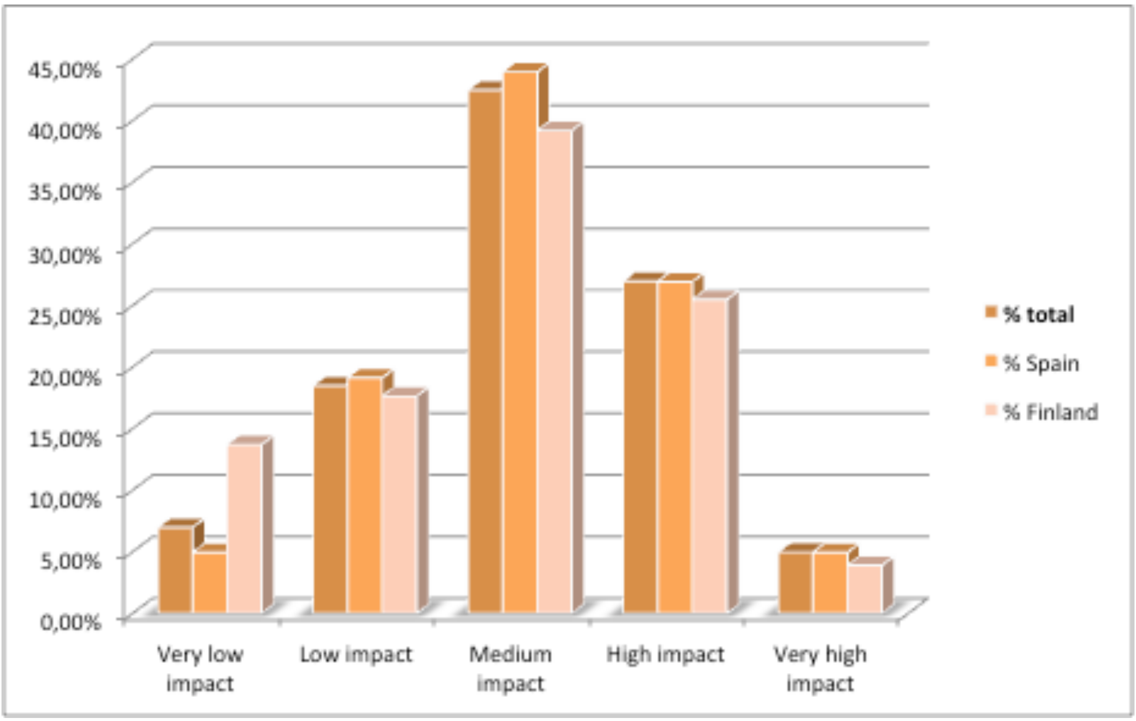
SPANISH ANSWERS



FINNISH ANSWERS

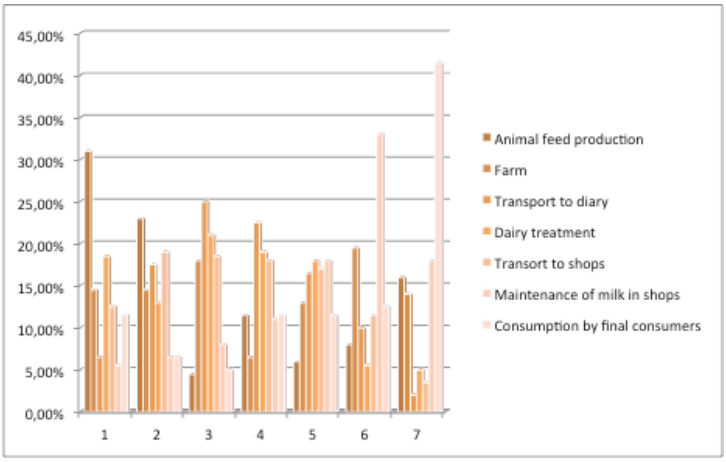


What impact do you think milk production has for environment?

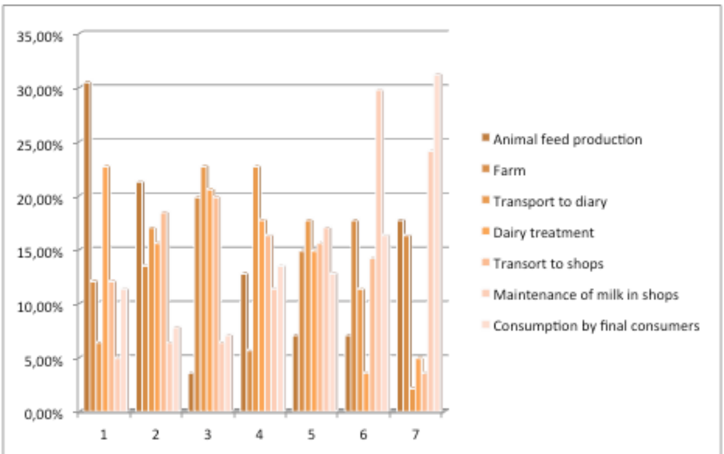

45,00%
40,00%
35,00%
30,00%
25,00%
20,00%
15,00%
10,00%
5,00%
0,00%
Very low impact
Low impact
Medium impact
High impact
Very high impact
% total
% Spain
% Finland

In what phase of milk production you think are the biggest impacts to environment

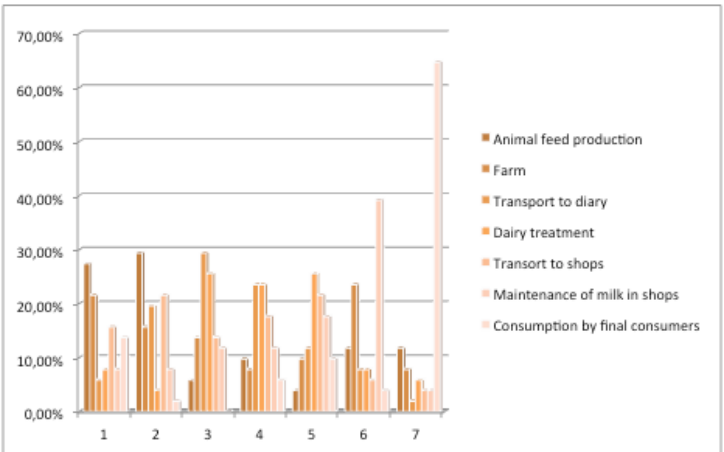
% TOTAL



% SPAIN

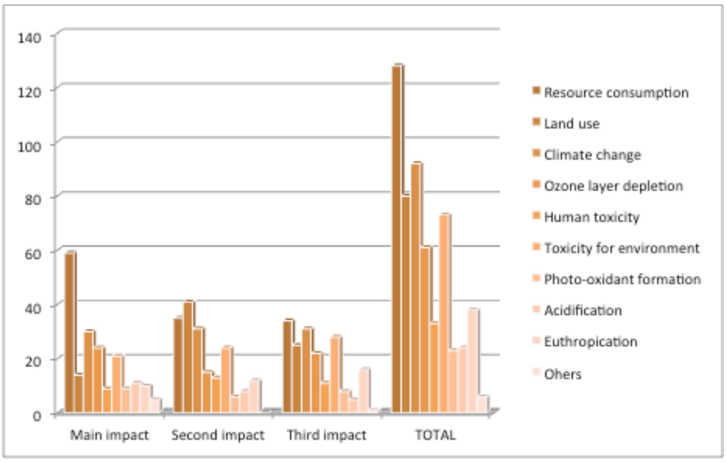


% FINLAND

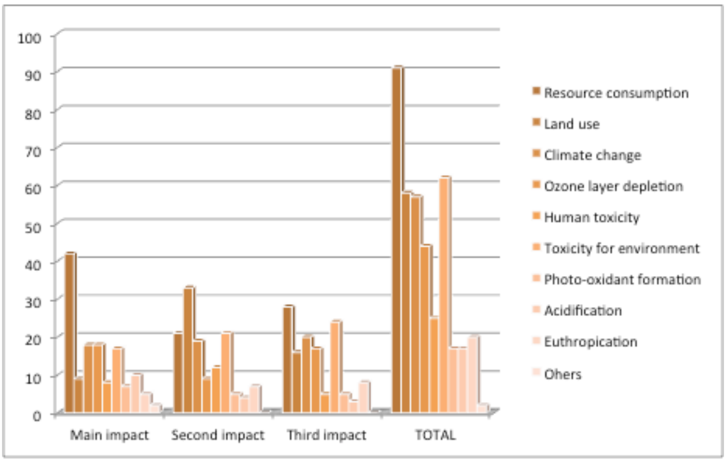


What type of negative impacts do you associate more to milk production? (Select up to 3 options, 1 (the main impact), 2 (the second impact) and 3 (the third impact))

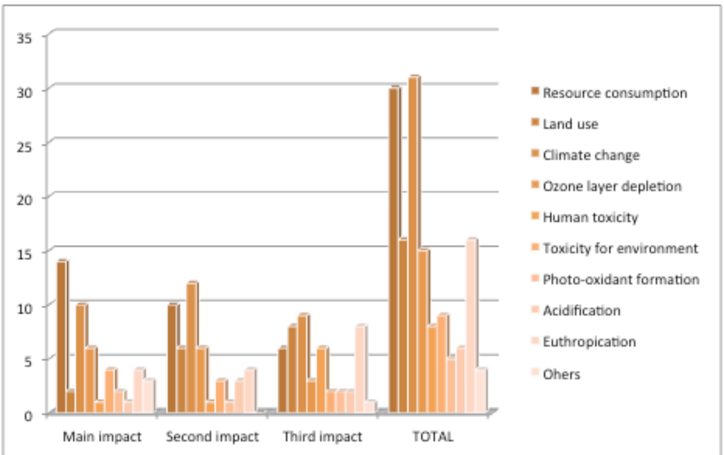
Total answers



Spanish answers



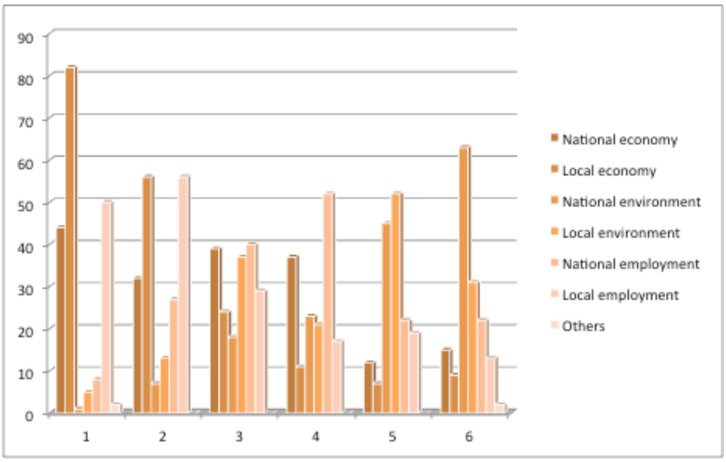
Finnish answers



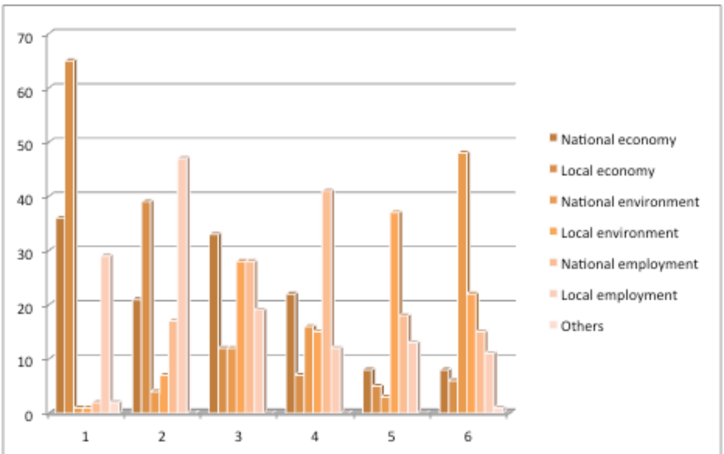
Assign values to the sectors positively affected by milk production

1 (the more positive affected sector) to 6 (the lowest positive affected sector)

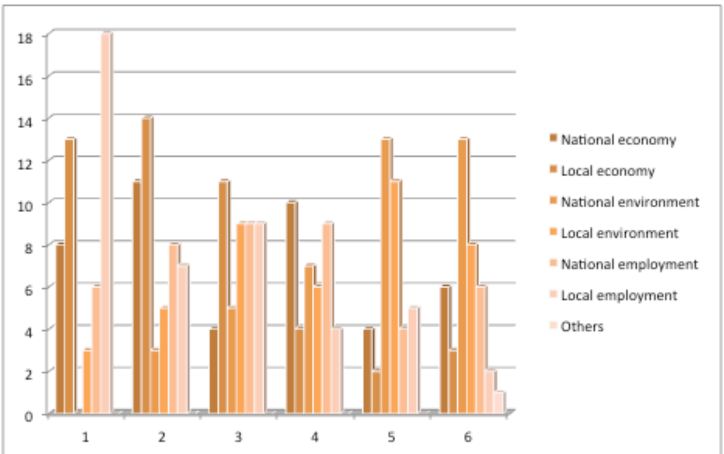
TOTAL ANSWERS



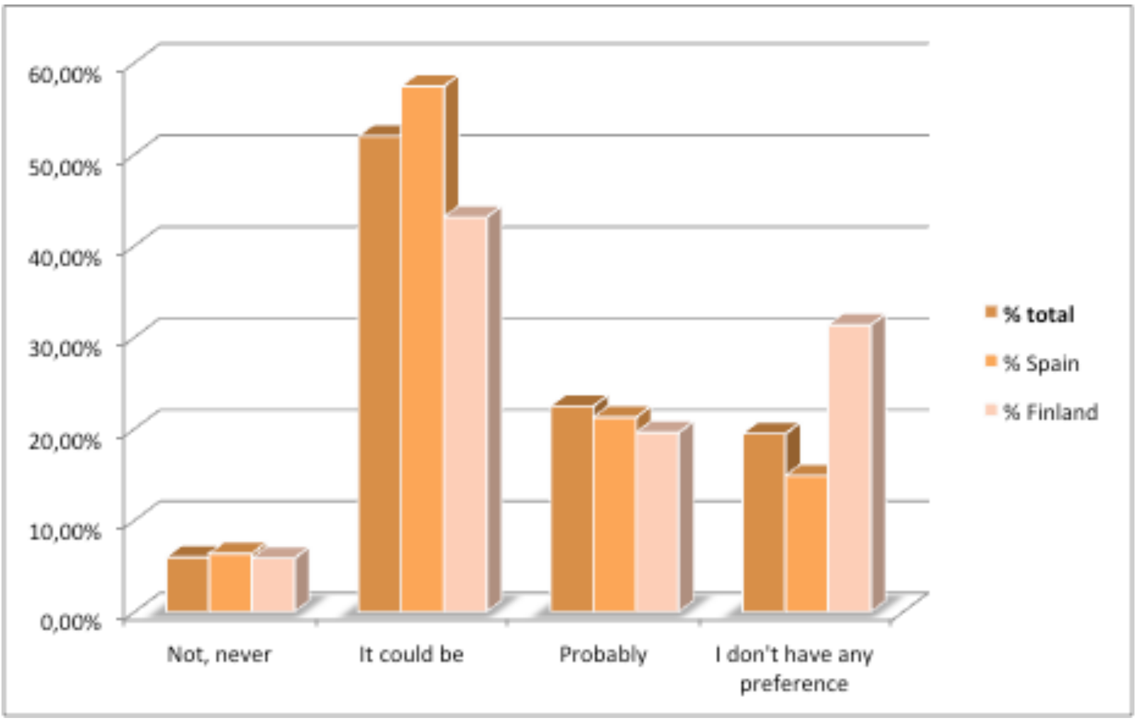
SPANISH ANSWERS



FINNISH ANSWERS

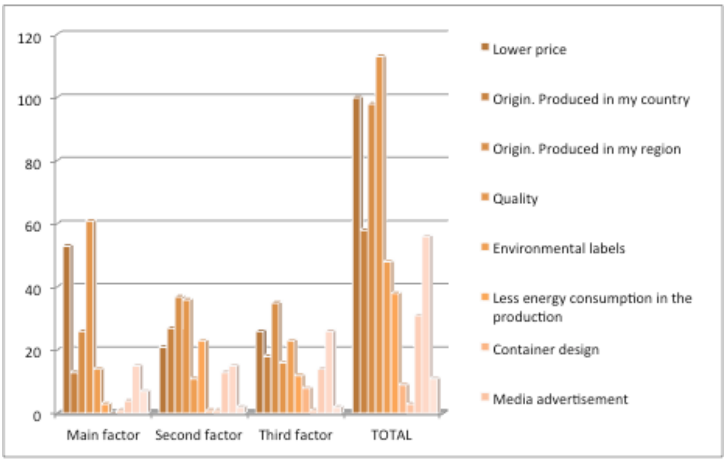


Would you change your normal brand for some other?

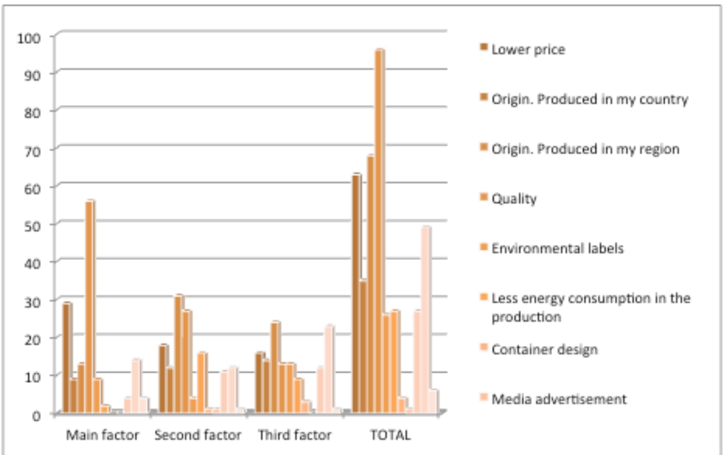

60,00%
50,00%
40,00%
30,00%
20,00%
10,00%
0,00%
Not, never
It could be
Probably
I don't have any preference
% total
% Spain
% Finland

What factors would you make to change your mind about milk brand? Select up to 3 options, 1 (the main factor), 2 (the second factor) and 3 (the third factor)

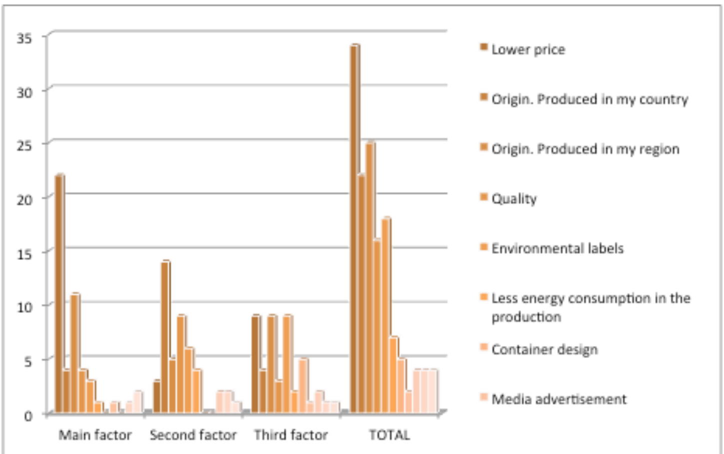
TOTAL ANSWERS



SPANISH ANSWERS

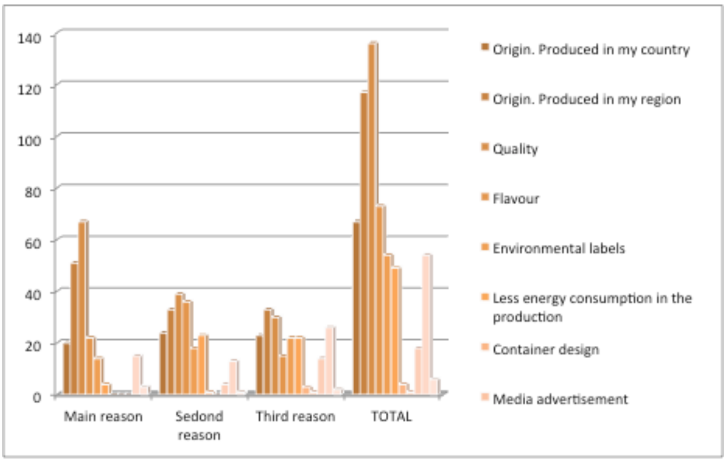


FINNISH ANSWERS

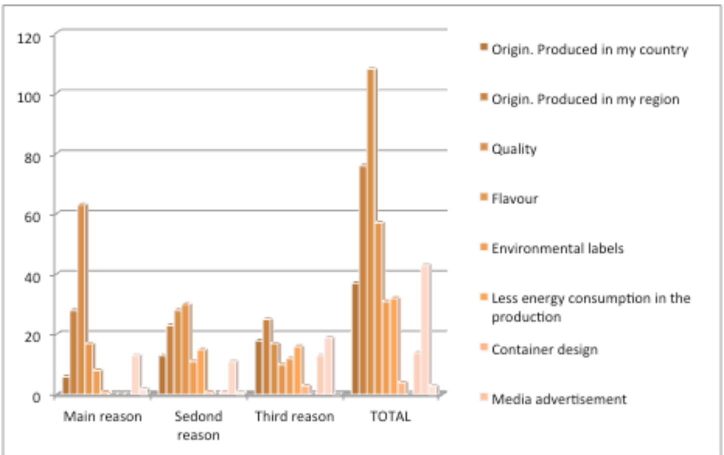


Would you pay an extra cost for some of these reasons? Select up to 3 options, 1 (the main reason to pay an extra cost), 2 (the second reason) and 3 (the third reason)

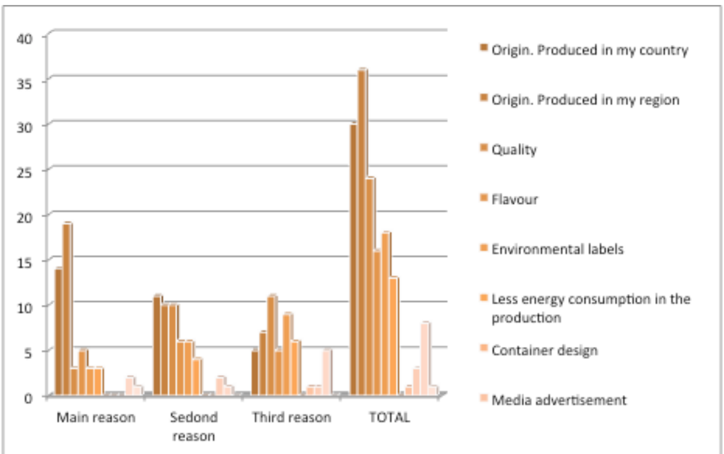
TOTAL ANSWERS



SPANISH ANSWERS

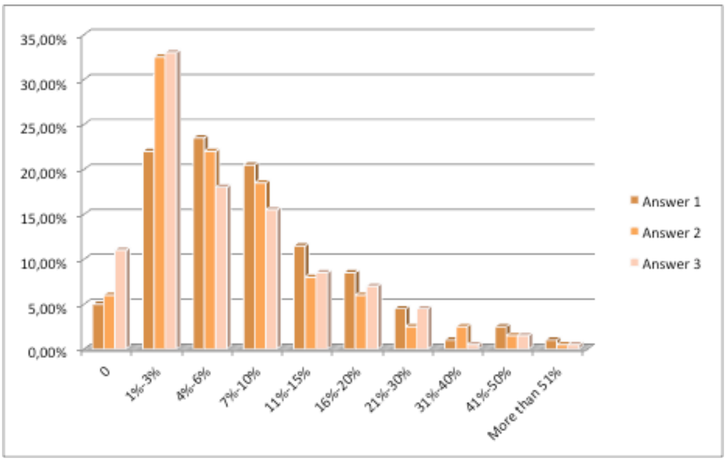


FINNISH ANSWERS

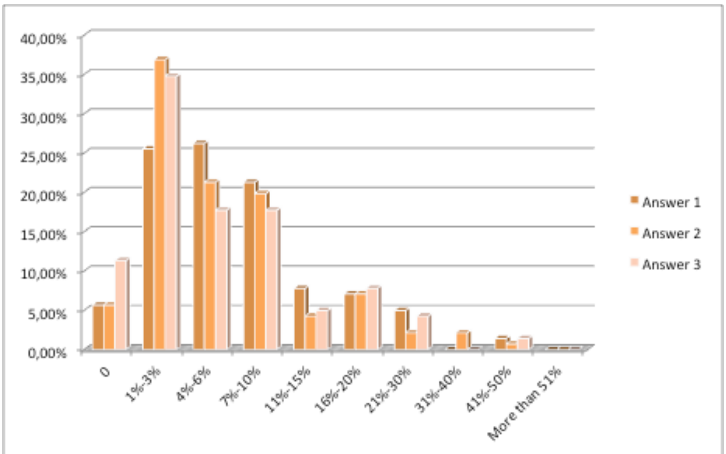


According to your selection in "extra cost" question, how much would you extra pay?

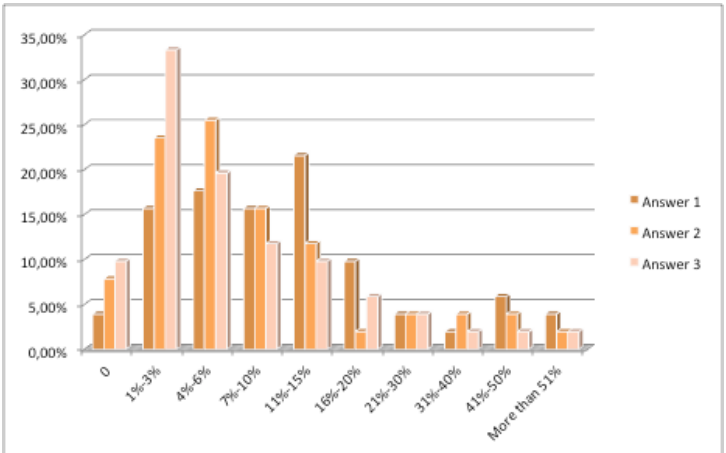
% Total



% Spain

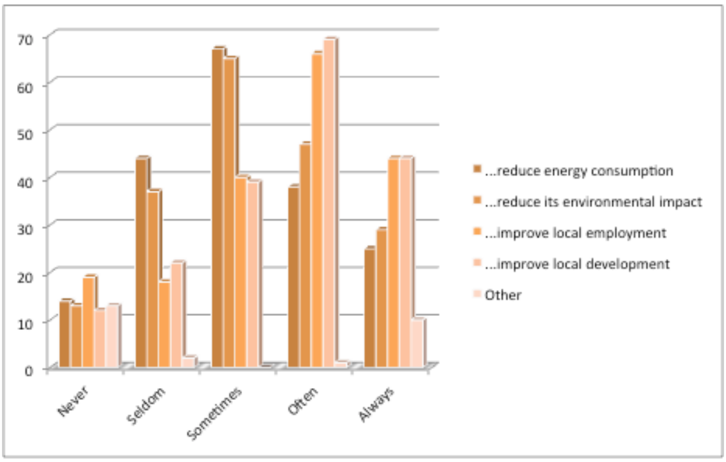


% Finland

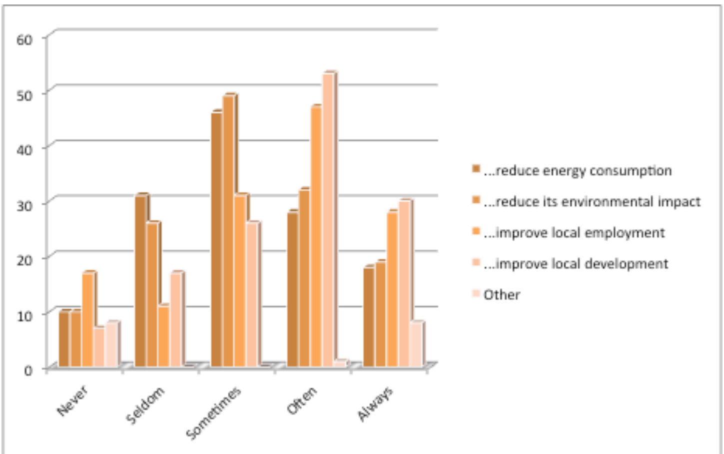


Would you choose a milk brand instead the tradicional one if the brand makes effort to…

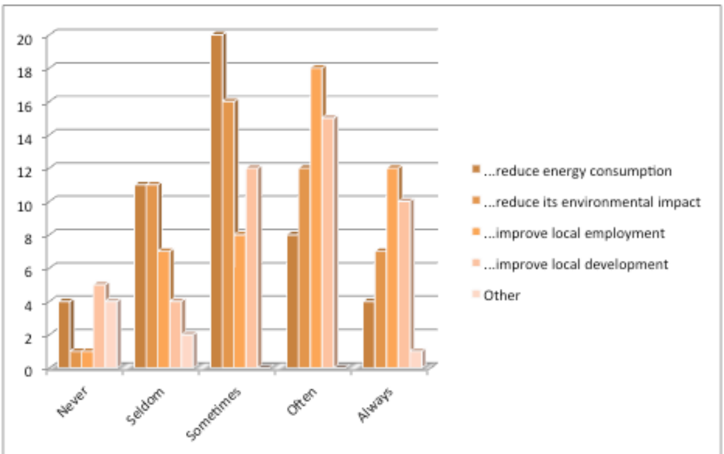
Total answers



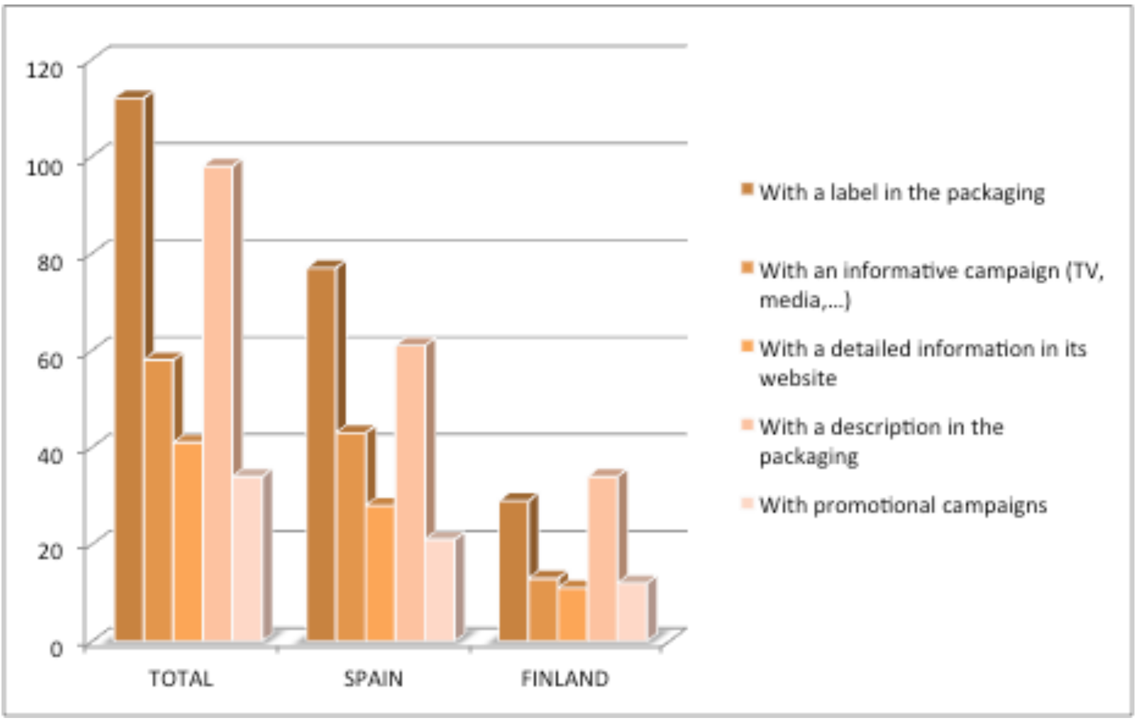
Spanish answers



Finnish answers



How would you like to be informed about these efforts?


120
100
80
60
40
20
0
TOTAL
SPAIN
FINLAND
With a label in the packaging
With an informative campaign (TV, media,...)
With a detailed information in its website
With a description in the packaging
With promotional campaigns

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